SITE CONDITIONS TECHNICAL MEMORANDUM
December 1997 Groundwater Sampling Results
Frontier Hard Chrome
Vancouver, Washington

Prepared for
U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

Contract No. 68-W9-0046
Work Assignment No. 46-38-027N
Work Order No. 4000-32-01-5100
Document Control No. 4000-32-01-AACF

May 1998

Prepared by
Roy F. Weston, Inc.
700 Fifth Avenue
Suite 5700
Seattle, WA 98104-5057

ARCS QUALITY ASSURANCE CONCURRENCE

Site Conditions Technical Memorandum
December 1997 Groundwater Sampling Results

Project Name:	Frontier Hard Chrome Vancouver, Washington
Contract Number:	68-W9-0046
Work Assignment Number:	46-38-027N
Responsible Organization:	Roy F. Weston, Inc. 700 Fifth Avenue, Suite 5700 Seattle, Washington 98104

Concurrences:

Name: Keith Pine
Title: Project Manager, Roy F. Weston, Inc.

Signature: Original Signed Date: 5/19/98

Name: Steve Fuller
Title: QA Manager, Roy F. Weston, Inc.

Signature: Original Signed Date: 5/20/98

Name: Frank C. Monahan, PE
Title: ARCS Program Manager, Roy F. Weston, Inc.

Signature: Original Signed Date: 5/20/98

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES *(Continued)*

LIST OF TABLES

SITE CONDITIONS TECHNICAL MEMORANDUM
SUPPLEMENTAL HYDROLOGICAL ANALYSIS
Frontier Hard Chrome Superfund Site
Vancouver, Washington

1. INTRODUCTION

This technical memorandum is a contract deliverable under the U.S. Environmental Protection Agency's (EPA's) Work Assignment No. 46-38-027N to Roy F. Weston, Inc. (WESTON®) under the Alternative Remedial Contracting Strategy (ARCS) Contract No. 68-W9-0046. This technical memorandum summarizes the results of groundwater sampling completed in December 1997 at the Frontier Hard Chrome (FHC) Superfund site located in Vancouver, Washington.

2. SCOPE

This work was performed in accordance with the procedures and methods specified in WESTON's Sampling and Analysis Plan (dated January 1997). The scope of services completed for this investigation consisted of groundwater level measurements and collecting groundwater samples from selected monitoring wells for chemical analysis of water quality parameters, total chromium, dissolved hexavalent chromium, selected total and dissolved priority pollutant metals, and total organic carbon (TOC).

2.1 Groundwater Conditions

The depth to groundwater levels were measured in the existing monitoring wells in December 1997. Water elevation data and potentiometric surface contour maps for the data collected in December 1997 were presented in WESTON (1998).

2.2 Groundwater Sampling and Analytical Results

Groundwater samples were collected from 24 selected monitoring wells in December 1997. The groundwater analytical program is summarized in **Table 1**. All groundwater samples were analyzed for unfiltered chromium, filtered iron and manganese, field water quality parameters, total organic carbon, and unfiltered priority pollutant metals; twelve selected samples were analyzed for filtered chromium and hexavalent chromium. The groundwater sampling procedure used during this investigation is presented in **Appendix A**. The laboratory data quality assurance/quality control reports are presented in **Appendix B**.

The inorganics and conventional groundwater quality parameter analyses were performed by EPA's Manchester laboratory in accordance with procedures described in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (EPA SW-846, 3rd edition; 1986).

2.3 Field Water Quality Parameters

The water quality parameters pH, temperature, oxygen, conductivity, and redox potential were measured in the field during groundwater sampling. The results of field water quality parameter testing are summarized in **Table 2**.

The pH values measured in groundwater at the site ranged from 5.0 to 7.5 with a median value of 6.6. The lowest pH values were recorded in W92-14P (5.0) and W92-14A (6.1). The pH concentrations are shown in Figure 1. The pH of most natural groundwater ranges from 6 to 8.5 (Hem, 1985). Conductivity in groundwater varied from 30 to 579 microsiemens (µS) with a median value of 259 µS. Conductivity is a function of the dissolved ionic materials in groundwater (Hem, 1985). Redox values were positive ranging from 178 to 321 millivolts (mV) with a median value of 282 mV. The redox data indicate that groundwater at the site is slightly to moderately oxidizing. Dissolved oxygen concentrations ranged from 0.04 to 6.9 mg/L with a median value of 0.64 mg/L. The December 1997 field parameters are in general agreement with the results of the February/March 1997 sampling event.

2.4 Chemistry Results

A list of monitoring wells sampled and analyses associated with each well are presented in **Table 1**. Metals analysis is frequently referred to as "total" or "dissolved"; and in that context, "total" generally refers to unfiltered water samples and "dissolved" refers to filtered water samples. In this report, metals analysis will be referred to as "filtered" or "unfiltered" rather than total and dissolved to avoid confusing unfiltered (total) chromium with total (i.e., trivalent plus hexavalent and other species) chromium. Filtered water samples were filtered in the field using a 0.45 µm filter.

2.5 Chromium

Groundwater samples from all locations were analyzed for unfiltered chromium and at selected locations for filtered chromium and hexavalent chromium. Chromium results are summarized in **Table 3**.

The highest concentration of unfiltered chromium (22,000 µg/L) was detected in monitoring well W92-14A. Concentrations of unfiltered chromium greater than 50 µg/L were detected in 9 of the 14 "A" zone well samples. Detected concentrations of unfiltered chromium in all of the "B" zone wells were less than 50 µg/L. The spatial distribution of unfiltered chromium in the "A" and "B" zone wells are shown in **Figures 2 and 3**.

Filtered hexavalent chromium concentrations ranged from 90 to 100 percent of unfiltered and filtered chromium values. The results indicate that there is little significant difference between hexavalent and filtered chromium values and indicate that essentially all of the chromium present in groundwater is in the hexavalent form. This result is consistent with previous analyses.

Groundwater concentrations of unfiltered chromium continue to decline in the majority (18 of 24) of wells. Historical concentration trends in unfiltered chromium for selected monitoring wells are presented in **Figures 4 through 24**.

2.6 Metals

Selected unfiltered metals and filtered iron and manganese were determined in all of the groundwater samples. Metal results are presented in **Table 4** and a statistical summary is included in **Appendix C**. Beryllium and selenium were not detected in any of the samples. Arsenic, lead, nickel, silver and thallium were detected in less than 6 of the samples. The concentration of cadmium and copper in perched and "A" zone well samples are shown in **Figures 25 and 26**. The maximum concentration of cadmium (8.9 µg/L) and copper (117 µg/L) was detected in W92-14A. Filtered iron and manganese concentrations for "A" and "B" zone wells are presented in **Figures 27 through 30**.

2.7 Total Organic Carbon

The distribution of total organic carbon (TOC) in groundwater in "A" and "B" level wells is presented in **Figures 31 and 32**. TOC results are presented in **Table 5**.

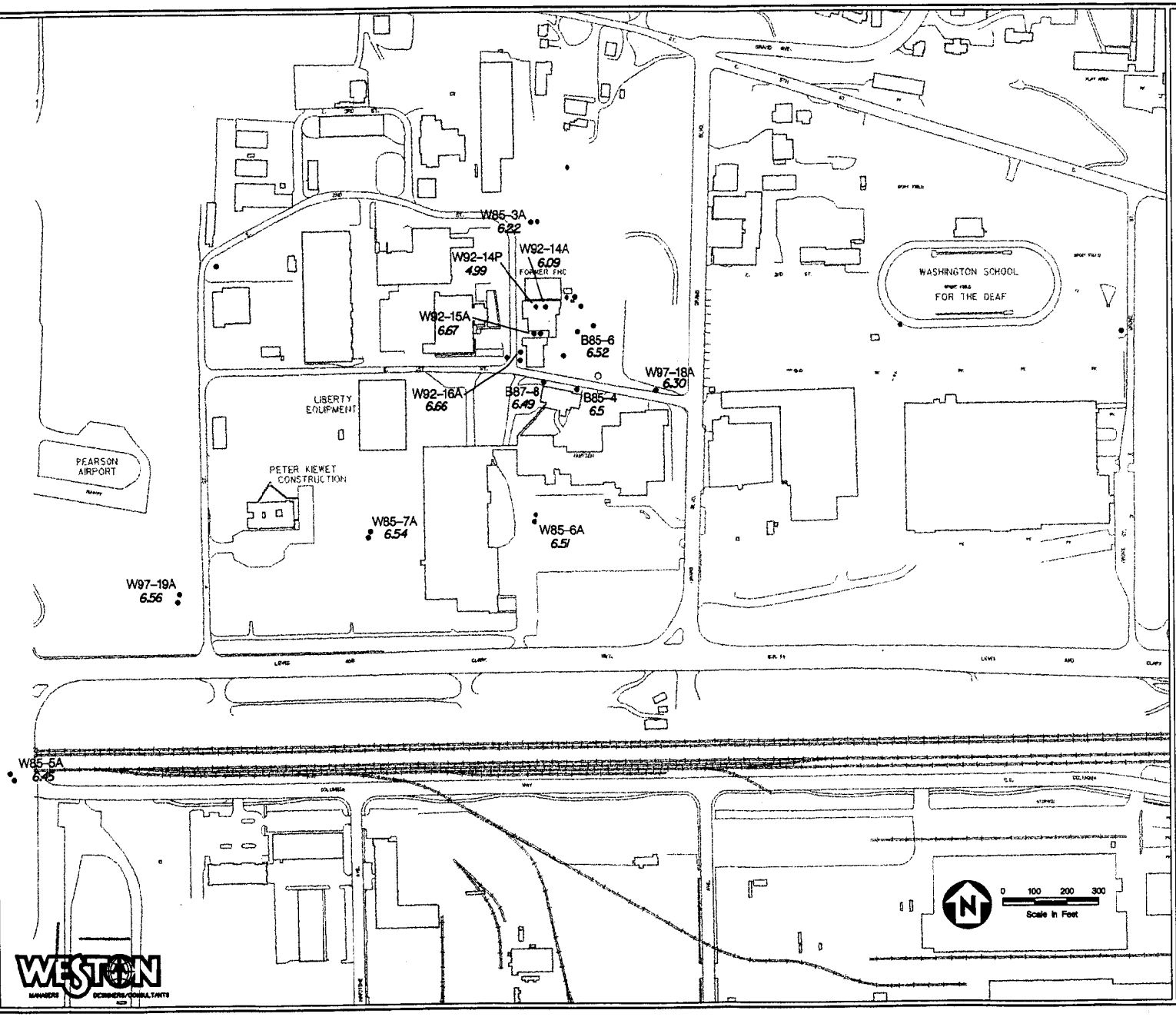
3. REFERENCES

Hem, J.D. 1985. Study and Interpretation of the Chemical Characteristics of Natural Water. United States Geological Survey Water Supply Paper 2254.

EPA (U.S. Environmental Protection Agency). 1986 and updates. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (EPA SW-846, 3rd Edition)

WESTON (Roy F. Weston, Inc.). 1998. Supplemental Hydrologic Analysis 29 February 1998.

FIGURES



EXPLANATION

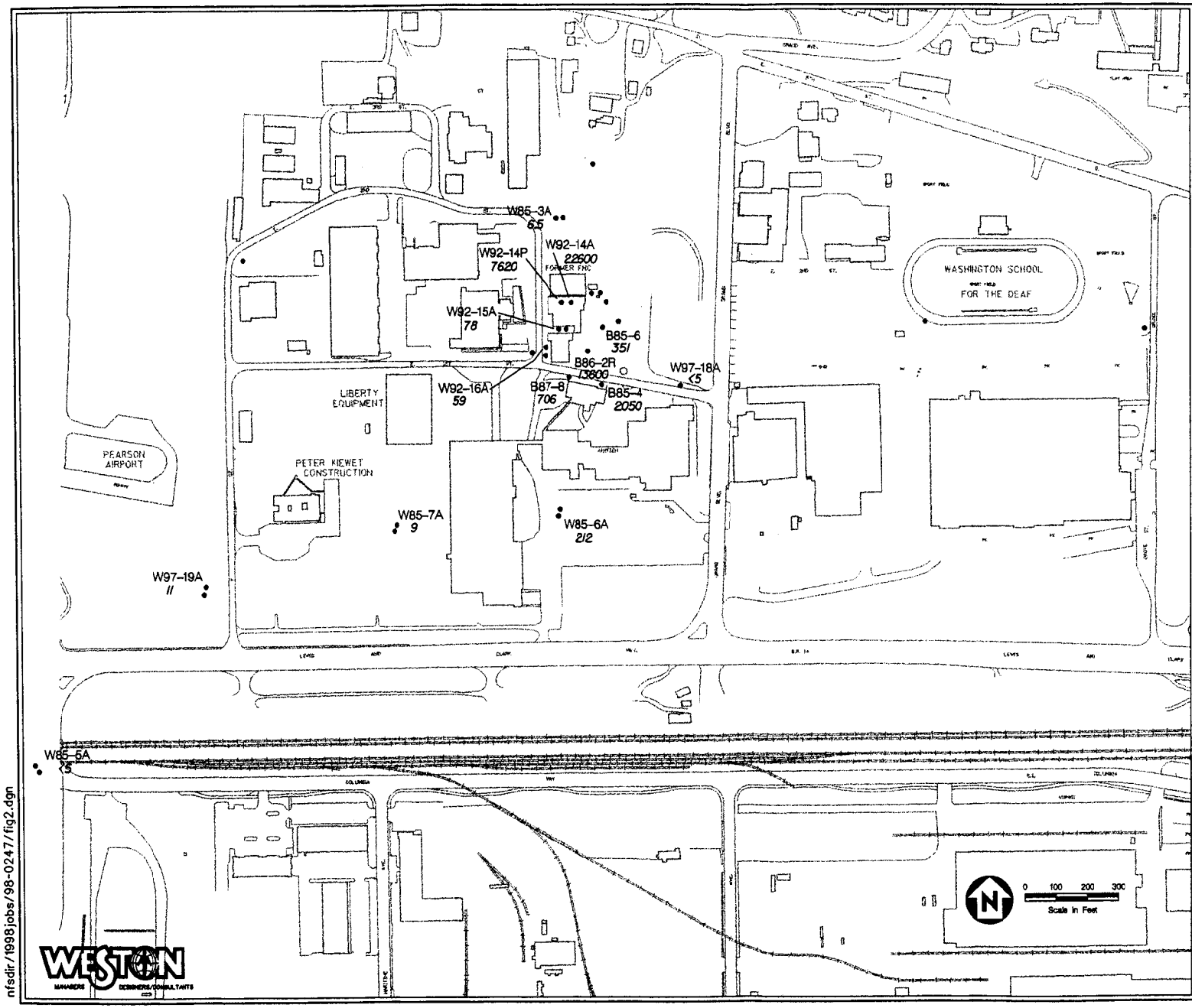
W85-3A
6.22 • Monitoring Well and December 1997 pH

Frontier Hard Chrome
pH of Groundwater
Perched and "A" Zone Aquifers
December 1997

FIGURE
1

WESTON
MANAGERS ENGINEERS/CONSULTANTS

n:\sdir\1998\jobs\98-0247\fig1.dgn



EXPLANATION

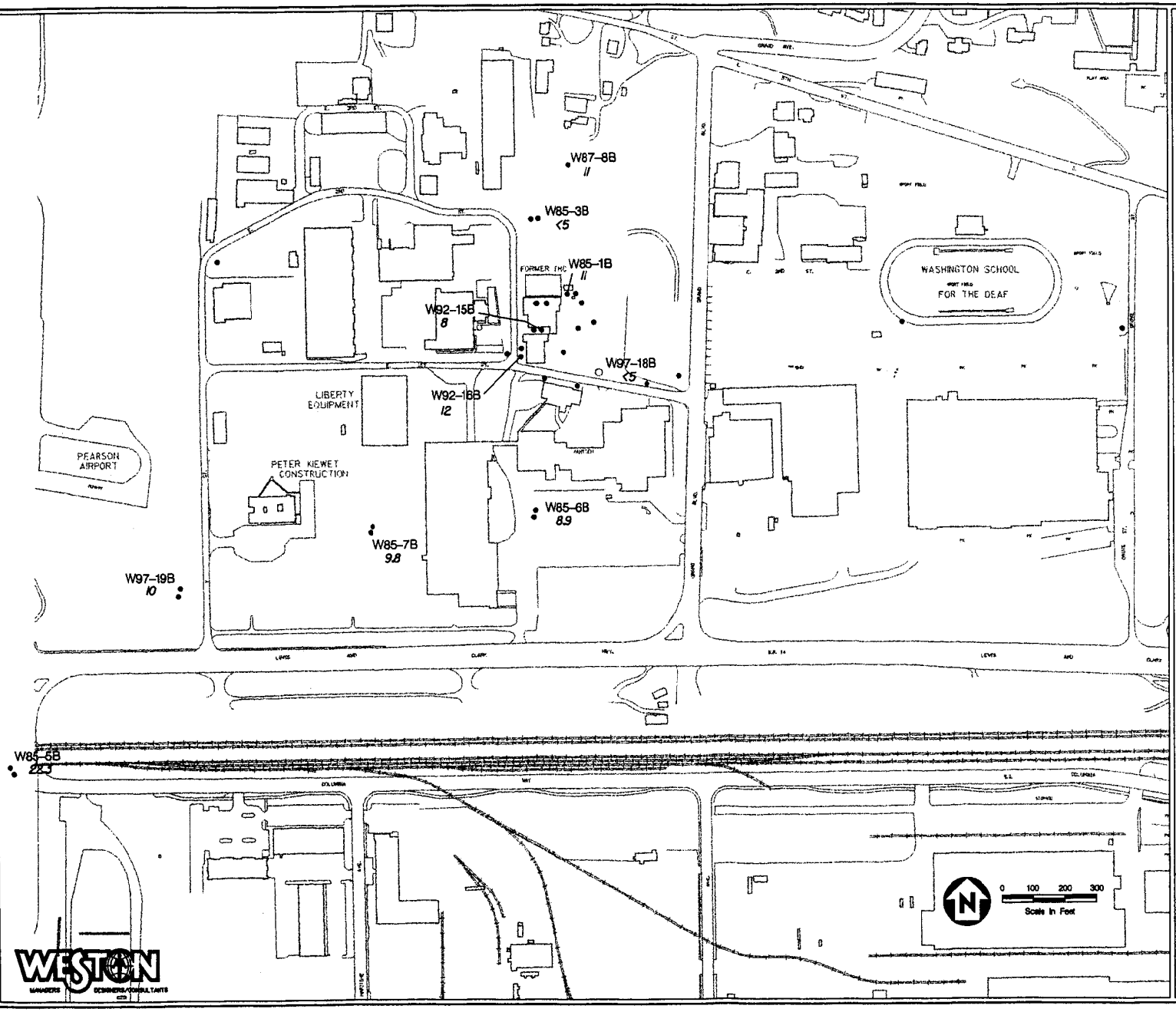
W85-3A
6.5
Monitoring Well and December 1997 Total Chromium Concentration (ug/L)

Frontier Hard Chrome
Unfiltered Chromium Concentration
in Groundwater
Perched and "A" Zone Aquifers
December 1997

FIGURE
2

WESTON MANAGERS DESIGNERS/CONSULTANTS

n:\sdir\1998\jobs\98-0247\fig2.dgn



EXPLANATION

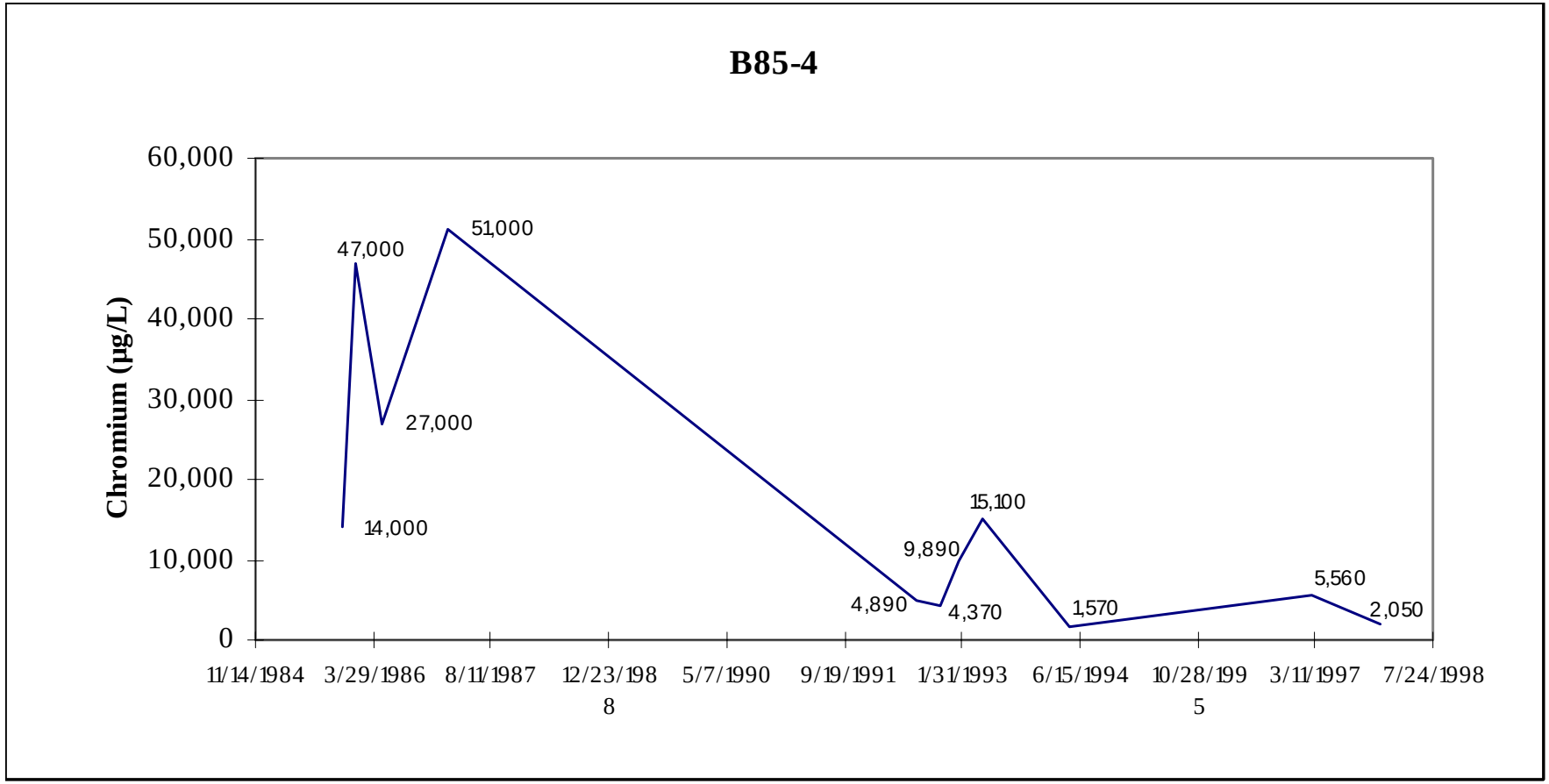
W85-7B
9.8
• Monitoring Well and December 1997 Total Chromium Concentration (ug/L)

Frontier Hard Chrome
Unfiltered Chromium Concentration
in Groundwater
"B" Zone Aquifer
December 1997

FIGURE
3

WESTON
MANAGERS DESIGNERS/CONSULTANTS

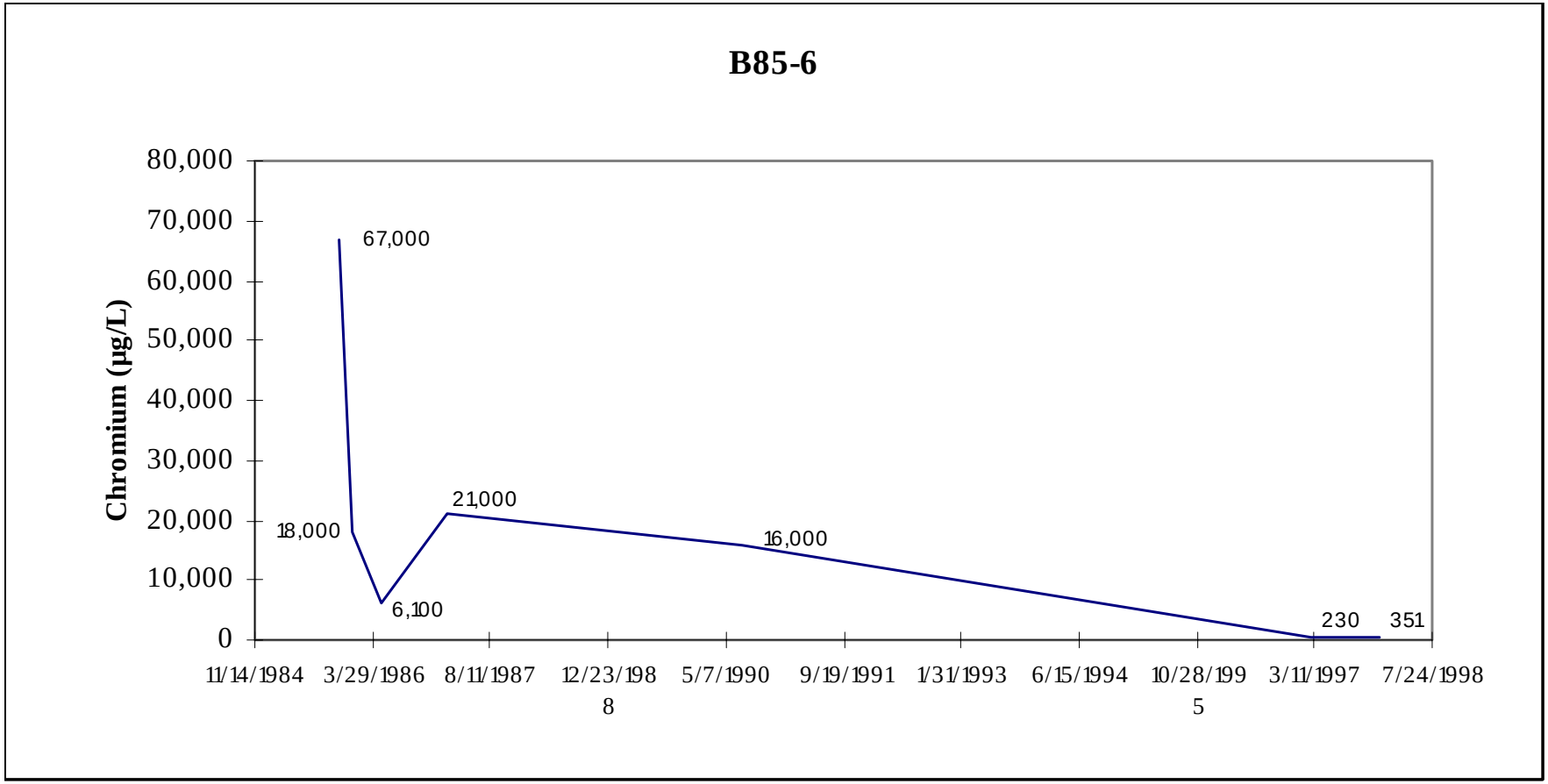
n:\sdir\1998\jobs\98-0247\fig3.dgn



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well B85-4

FIGURE
4

98-0247.ppt

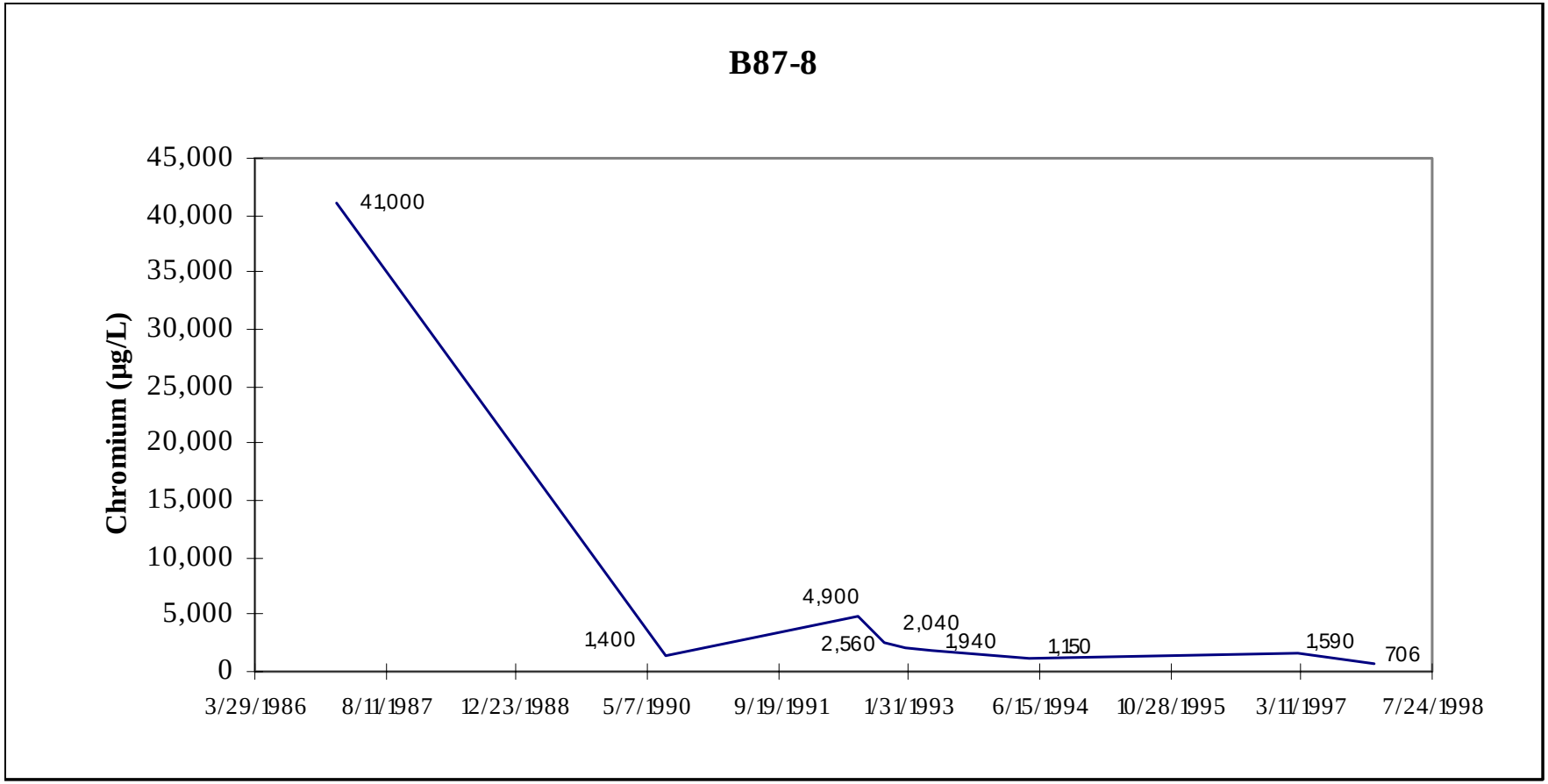


Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well B85-6

FIGURE

5

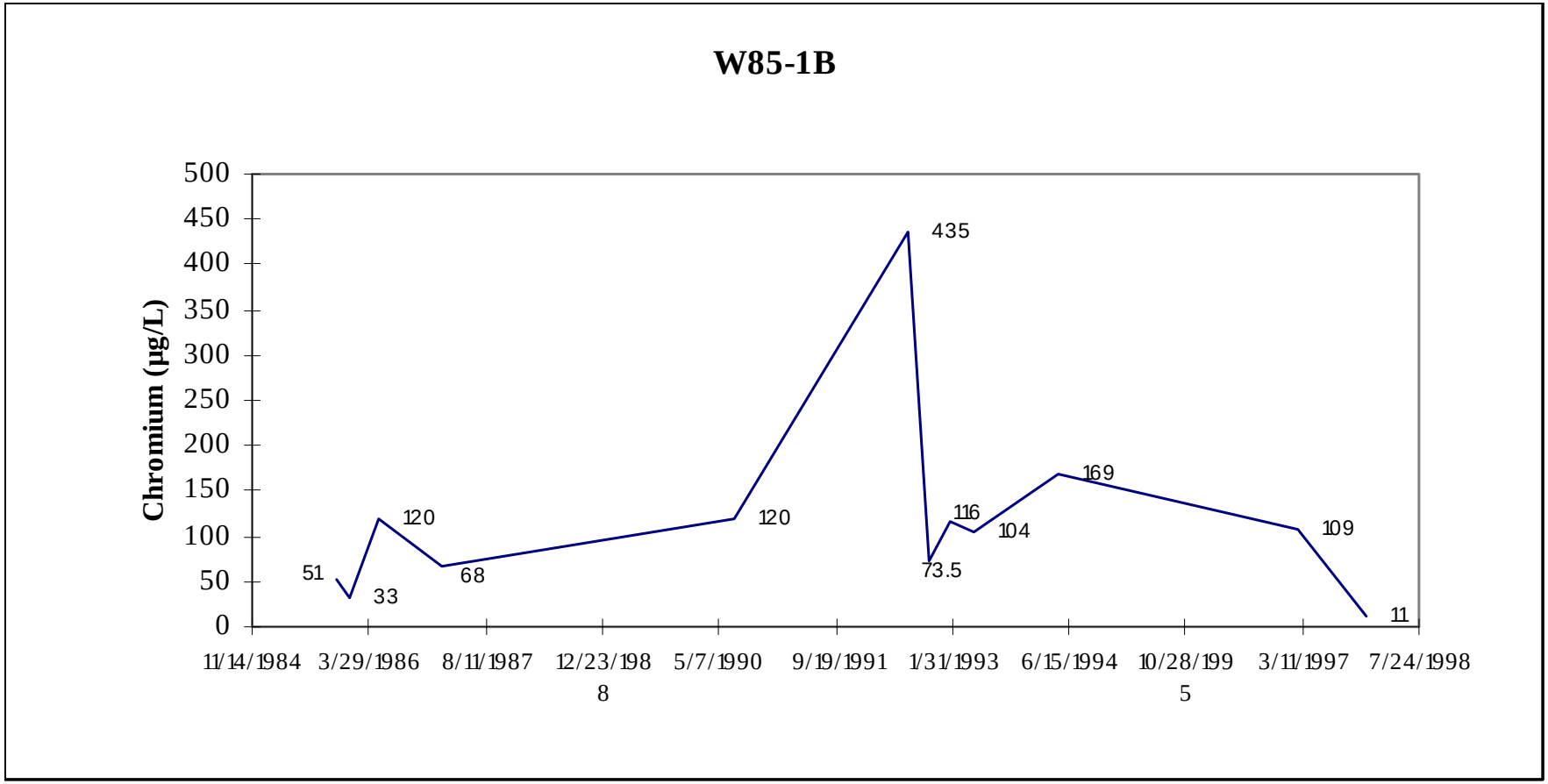
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well B87-8

FIGURE
6

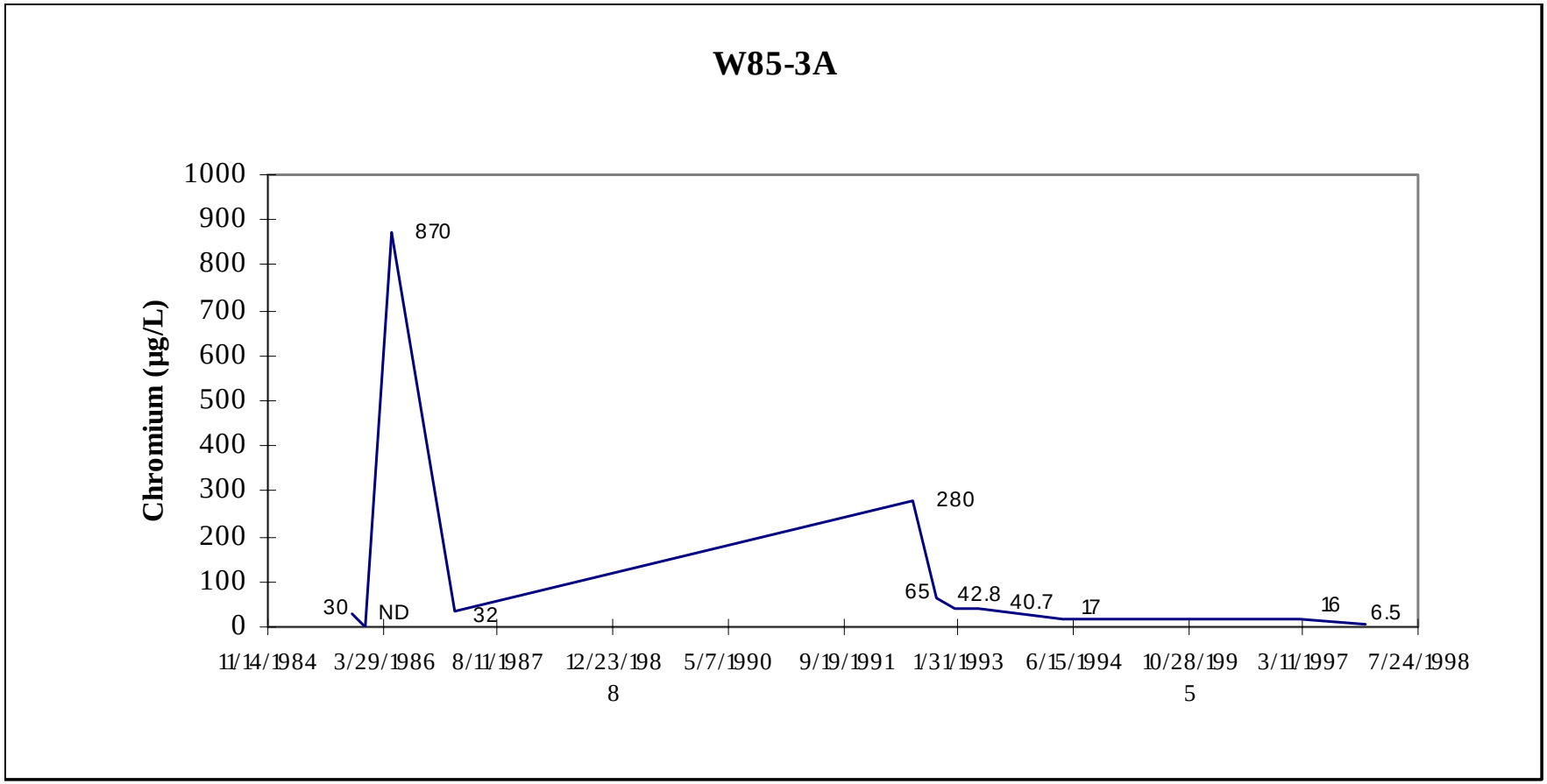
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W85-1B

FIGURE
7

98-0247.ppt

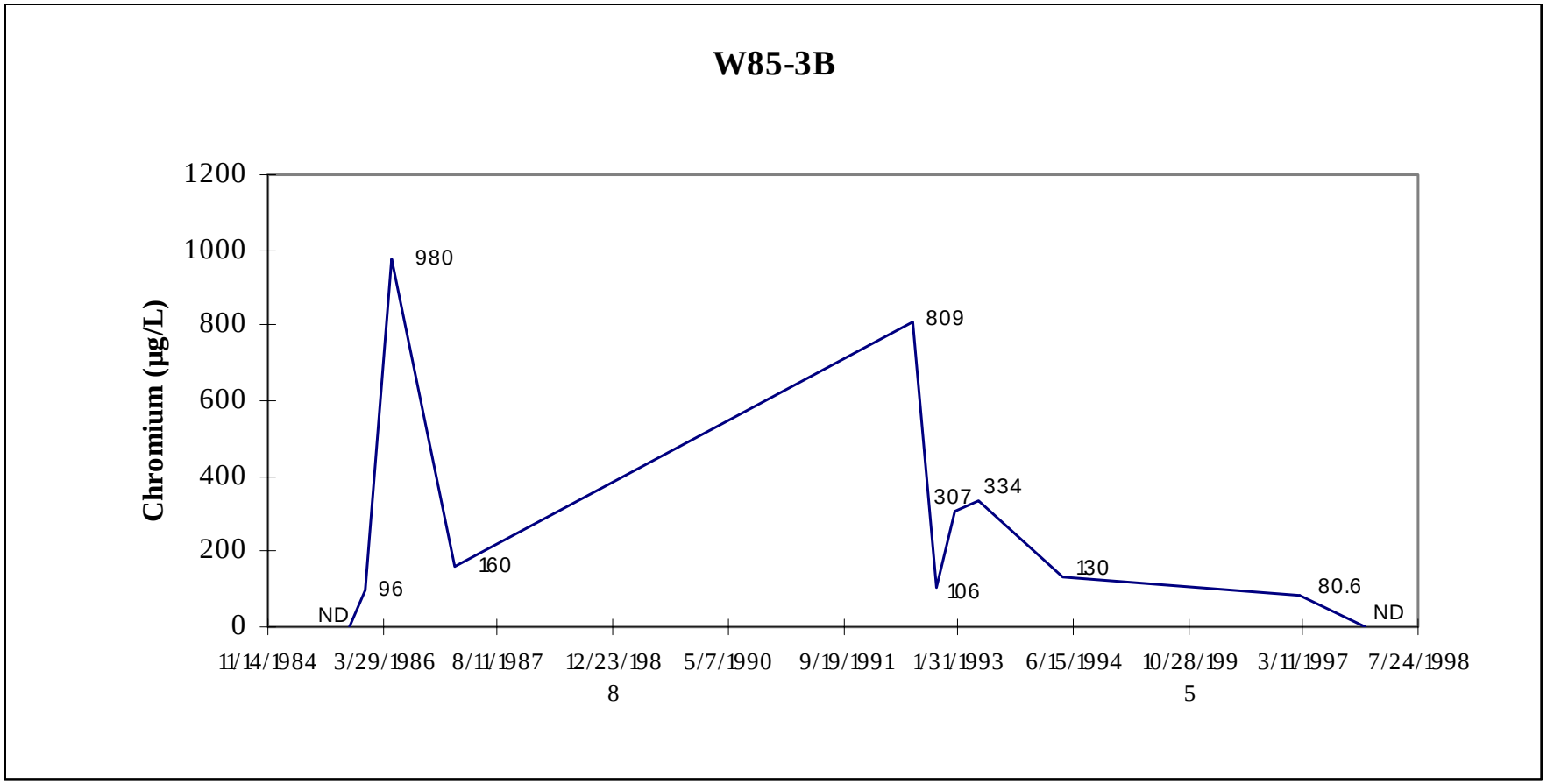


Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W85-3A

FIGURE

8

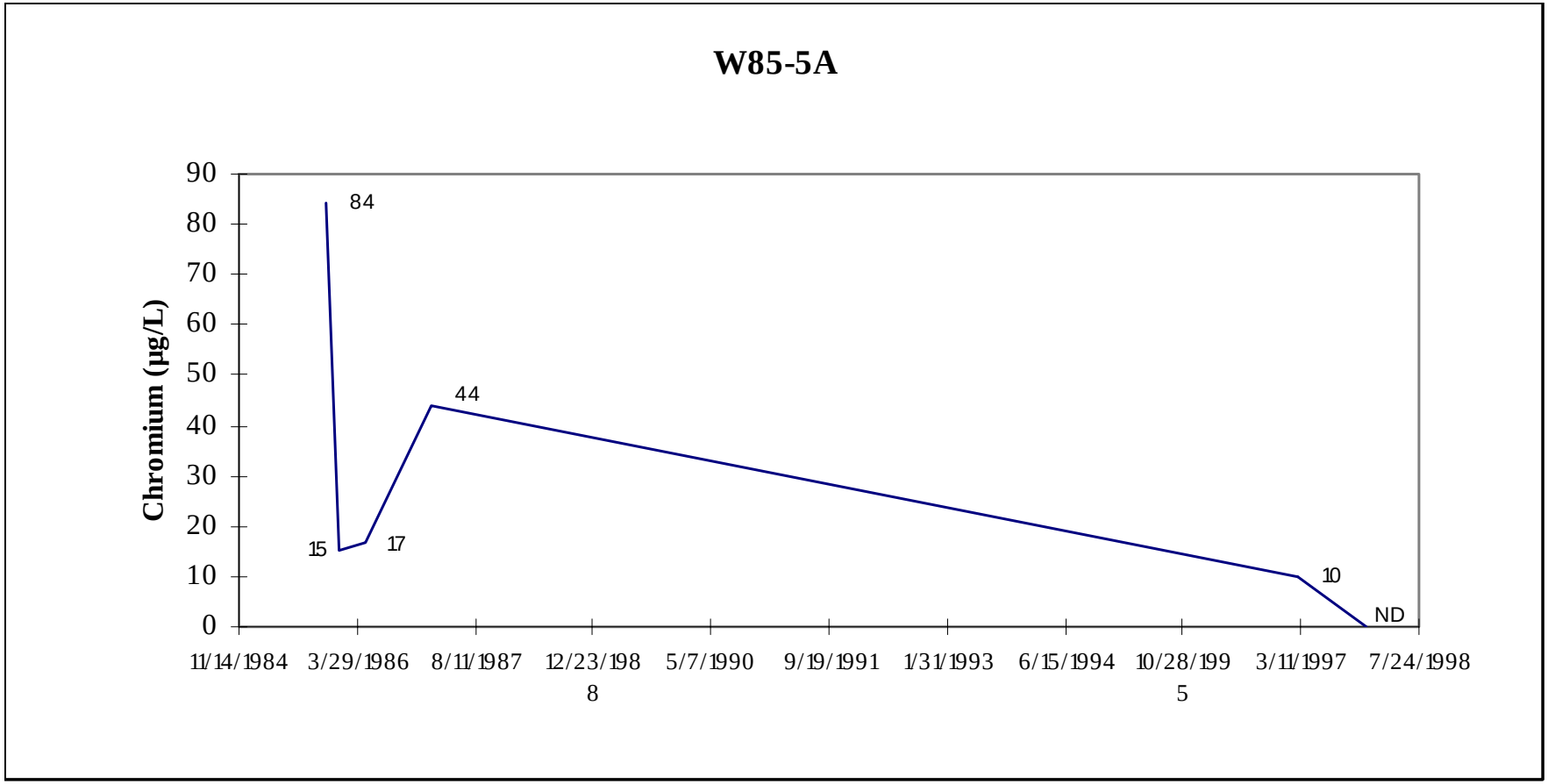
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W85-3B

FIGURE
9

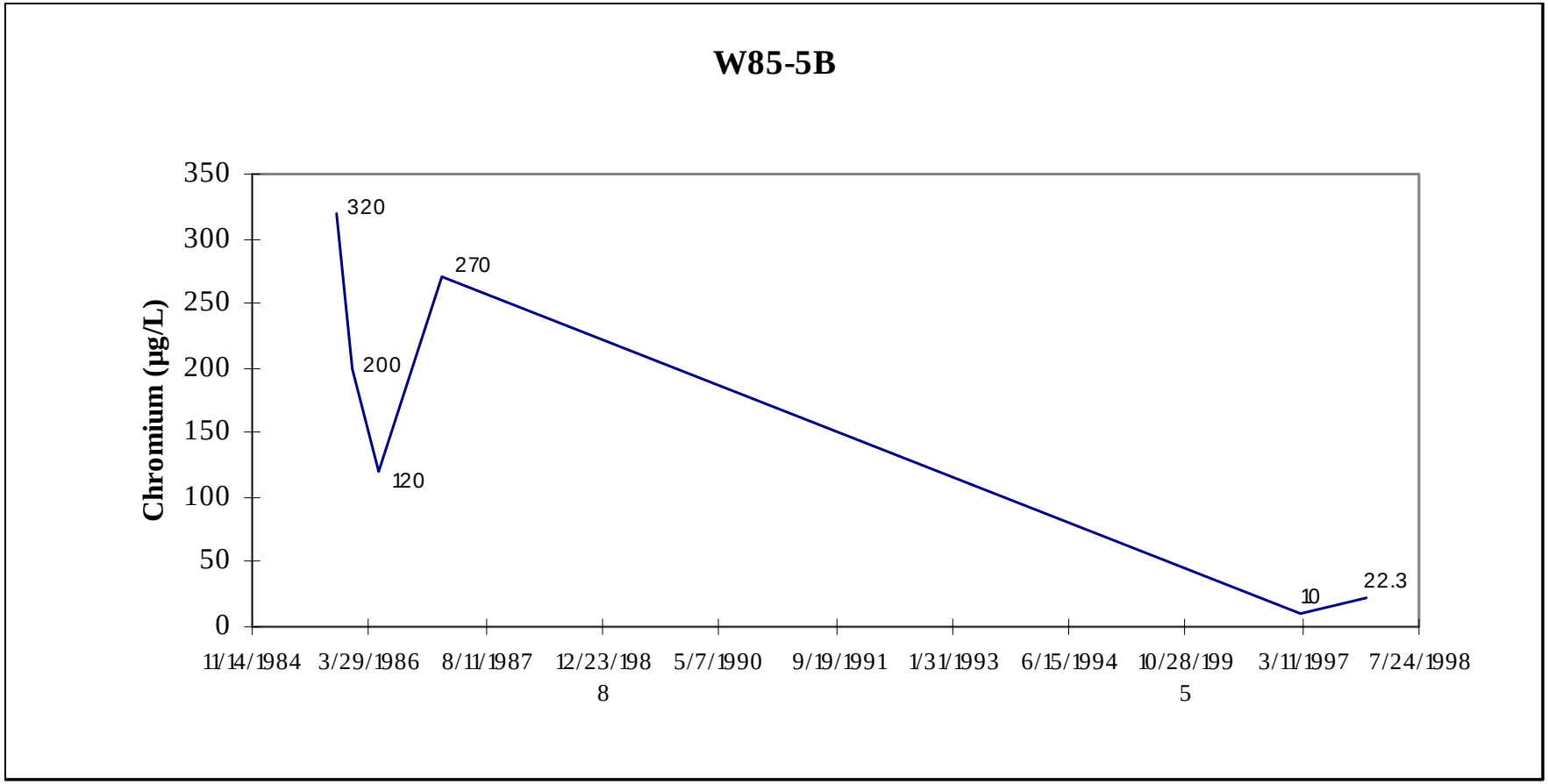
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W85-5A

FIGURE
10

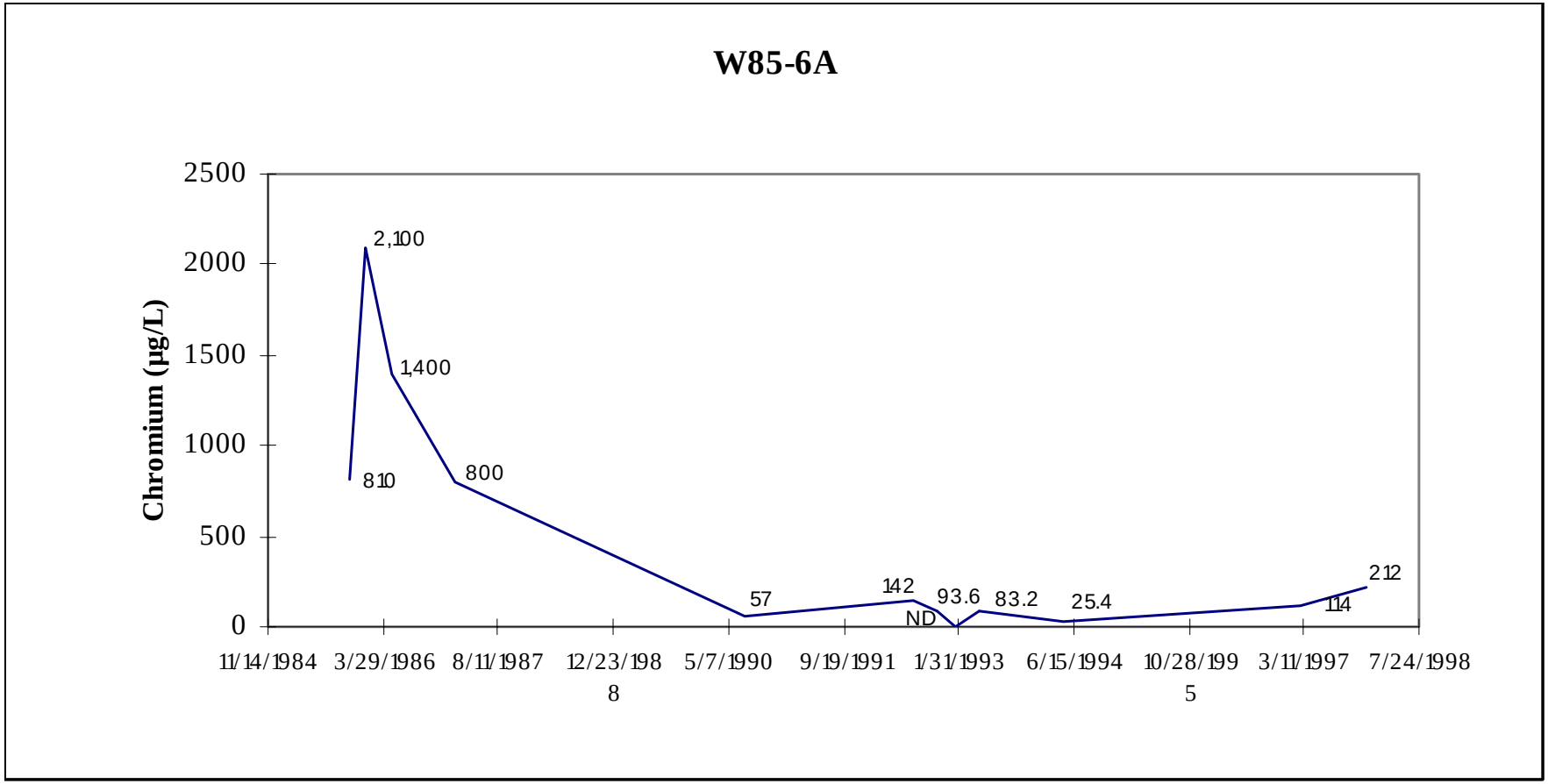
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W85-5B

FIGURE
11

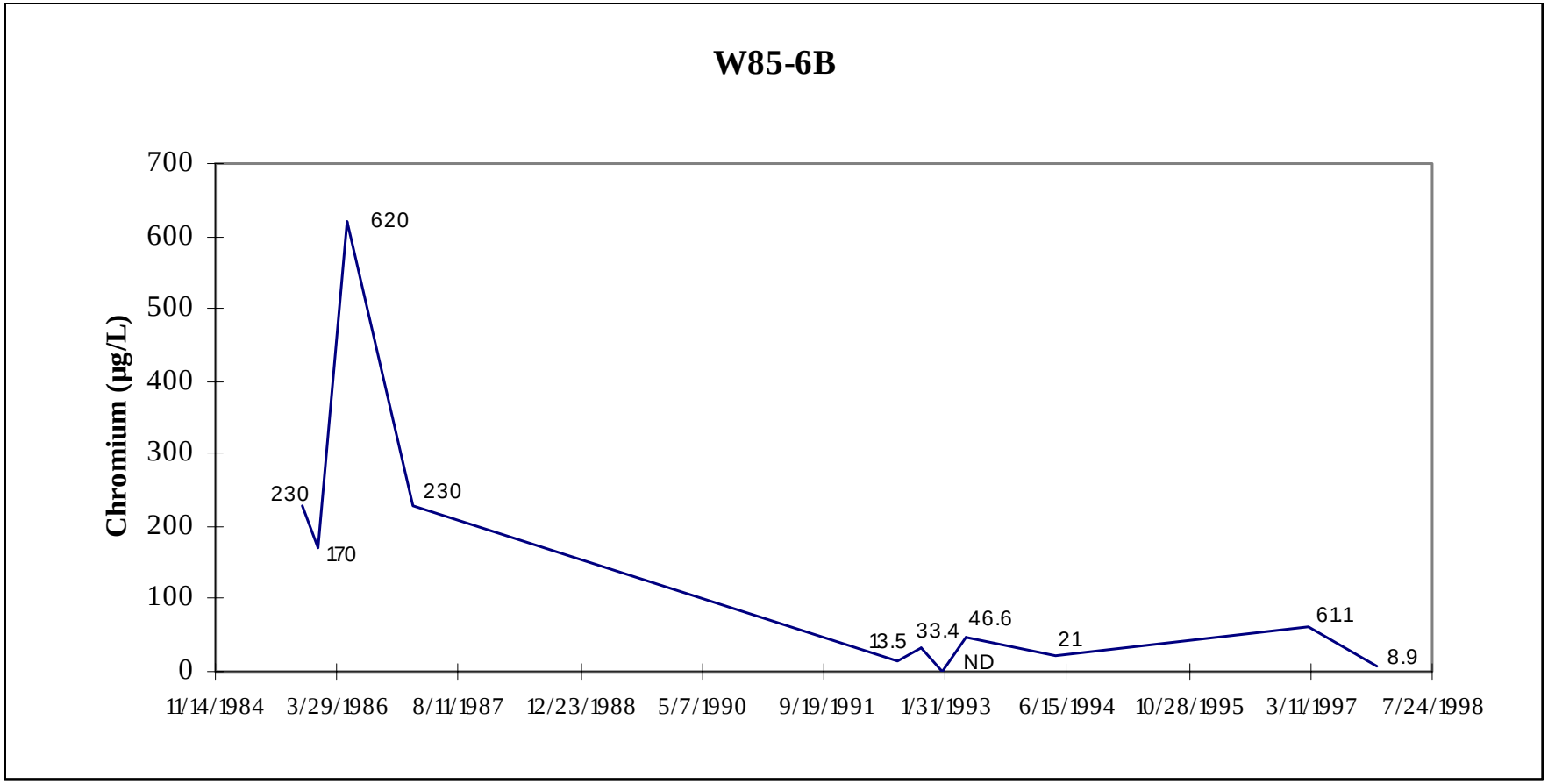
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W85-6A

FIGURE
12

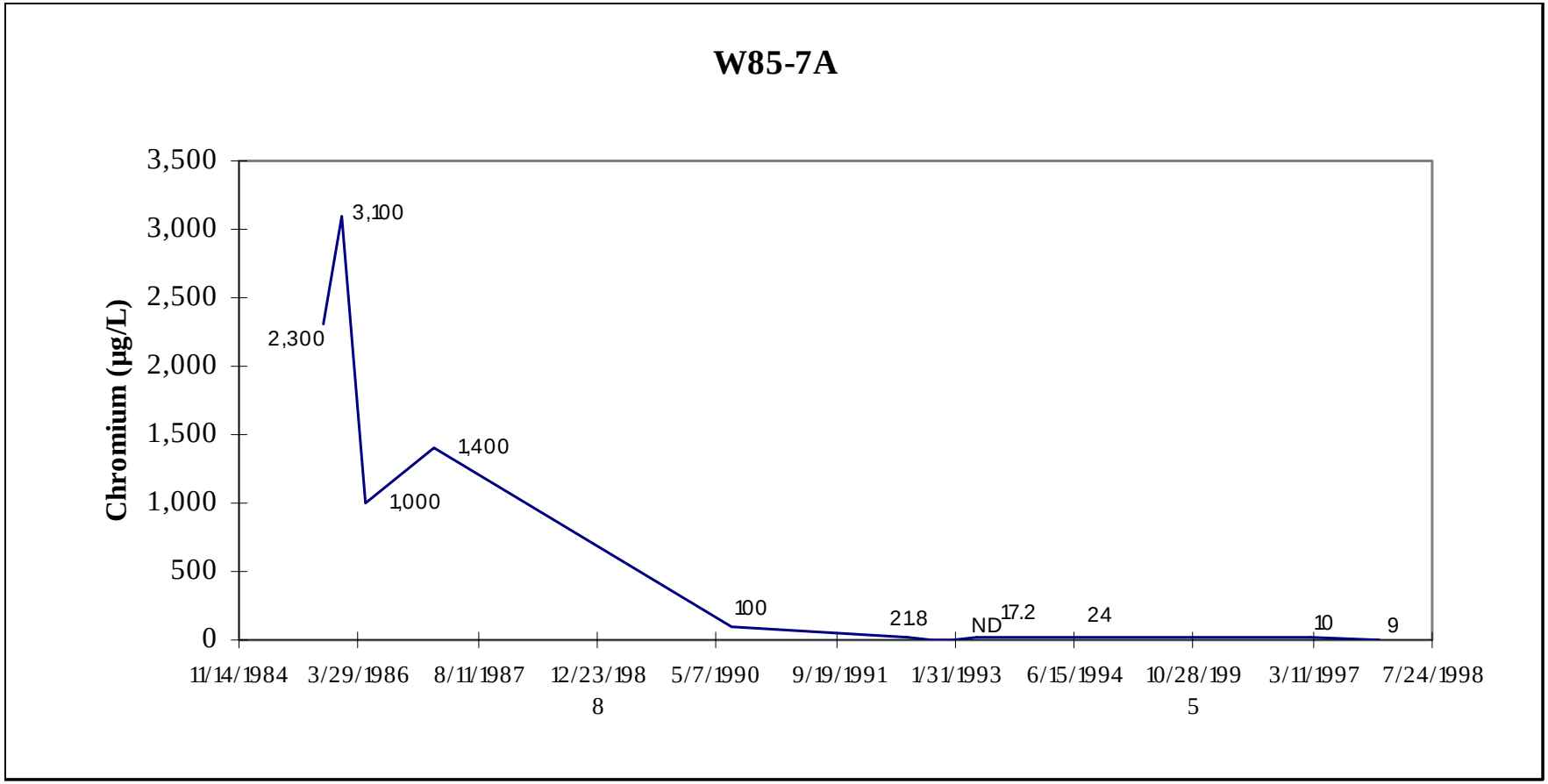
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W85-6B

FIGURE
13

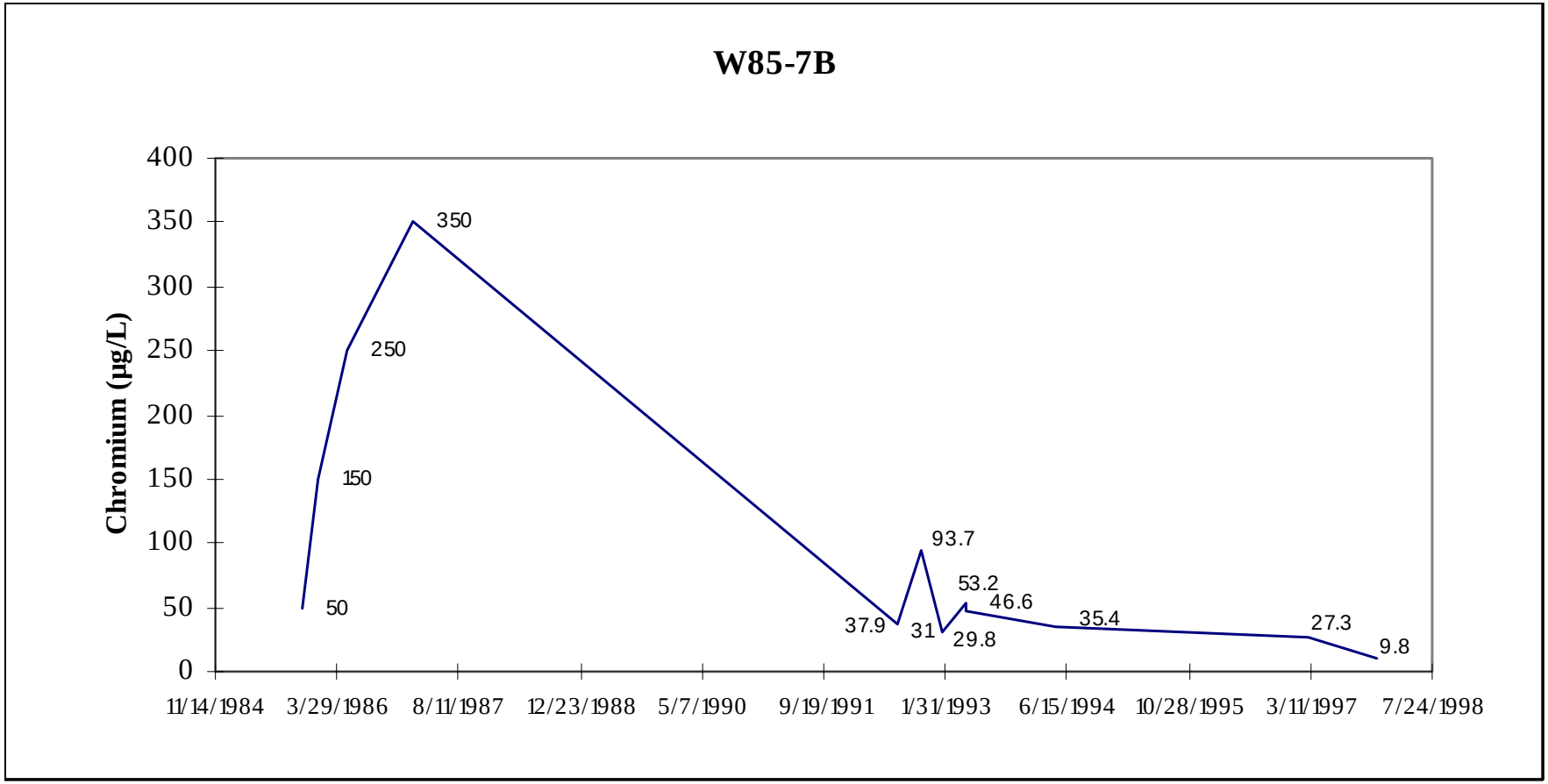
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W85-7A

FIGURE
14

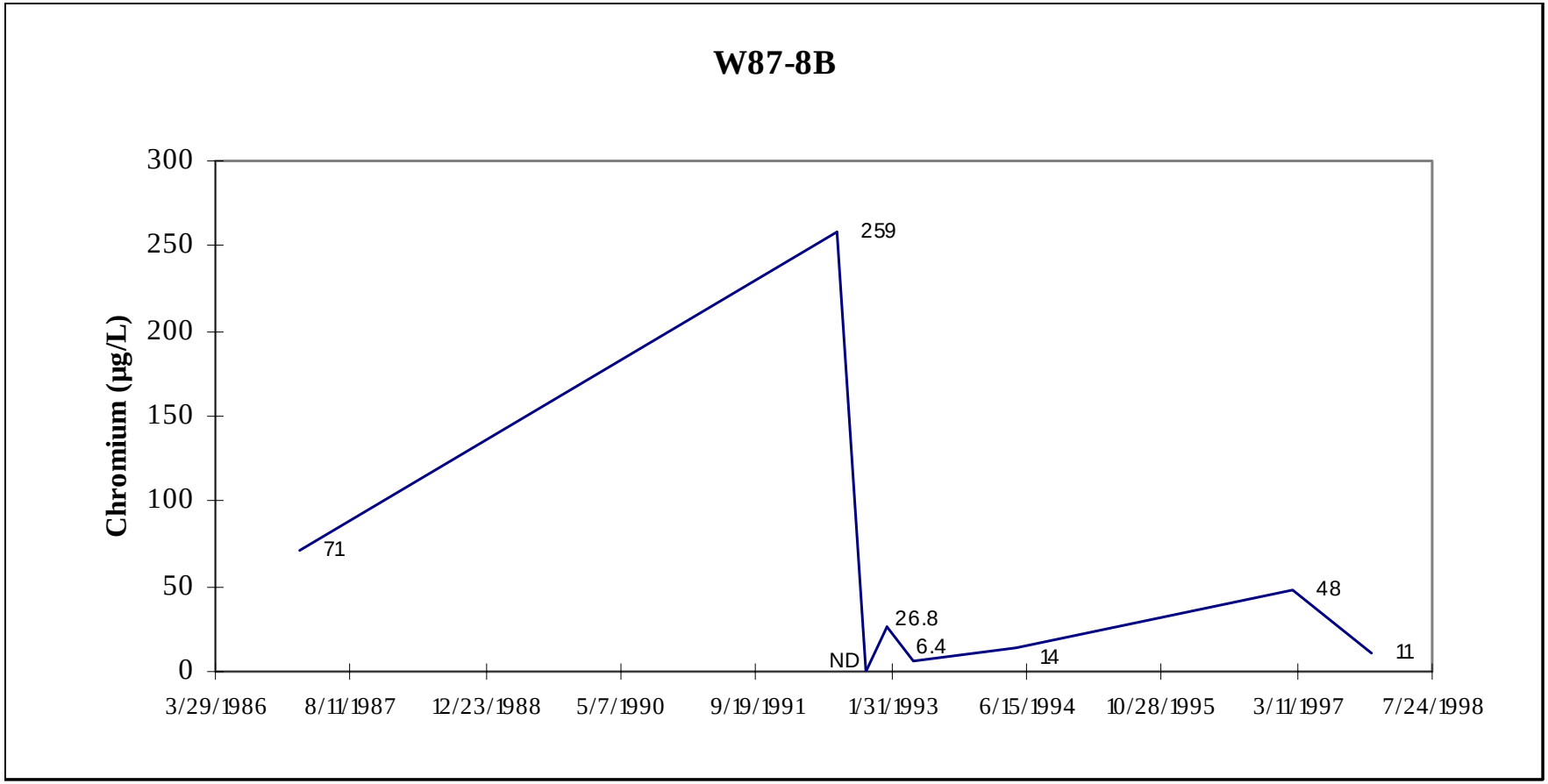
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W85-7B

FIGURE
15

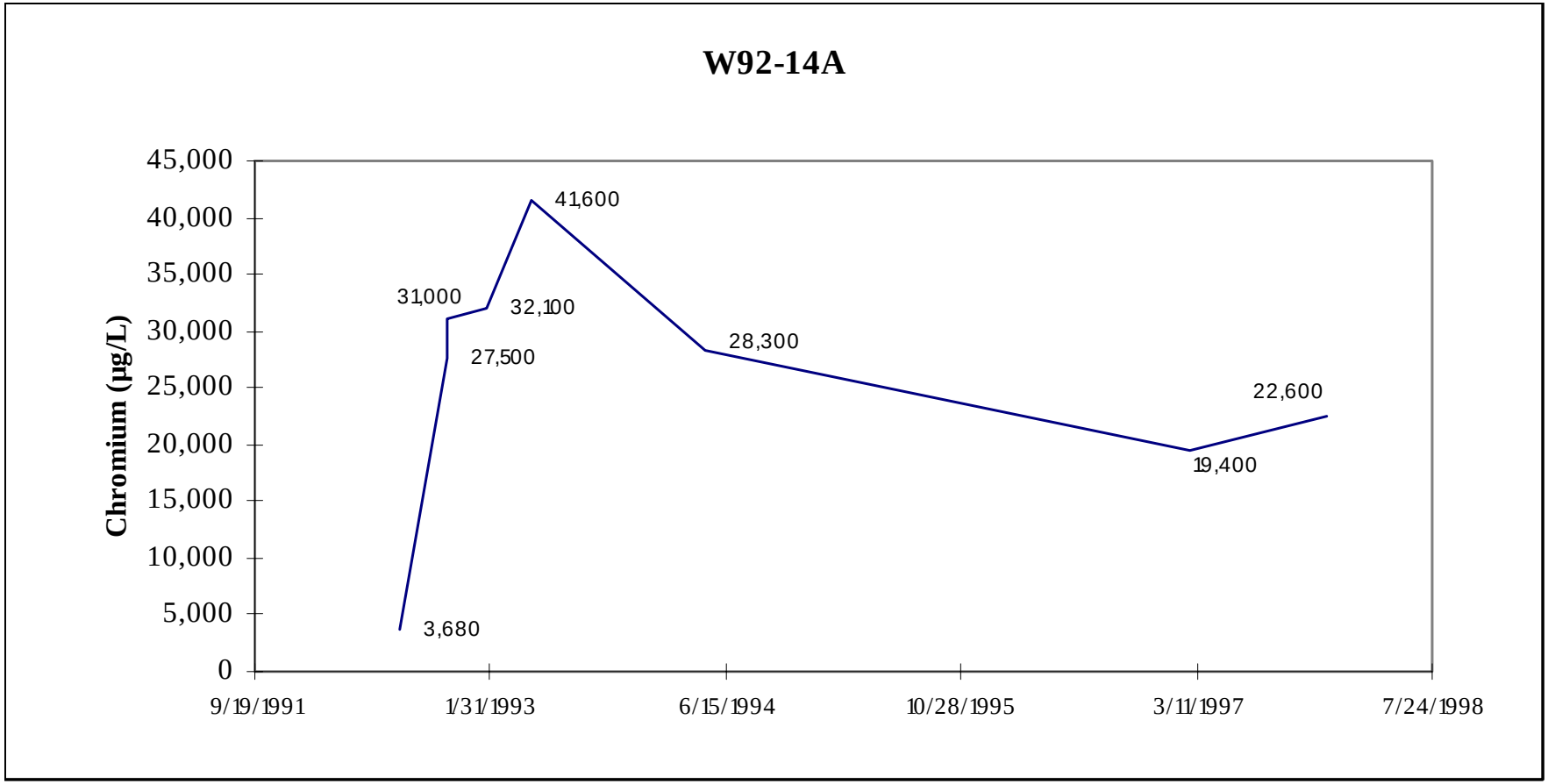
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W87-8B

FIGURE
16

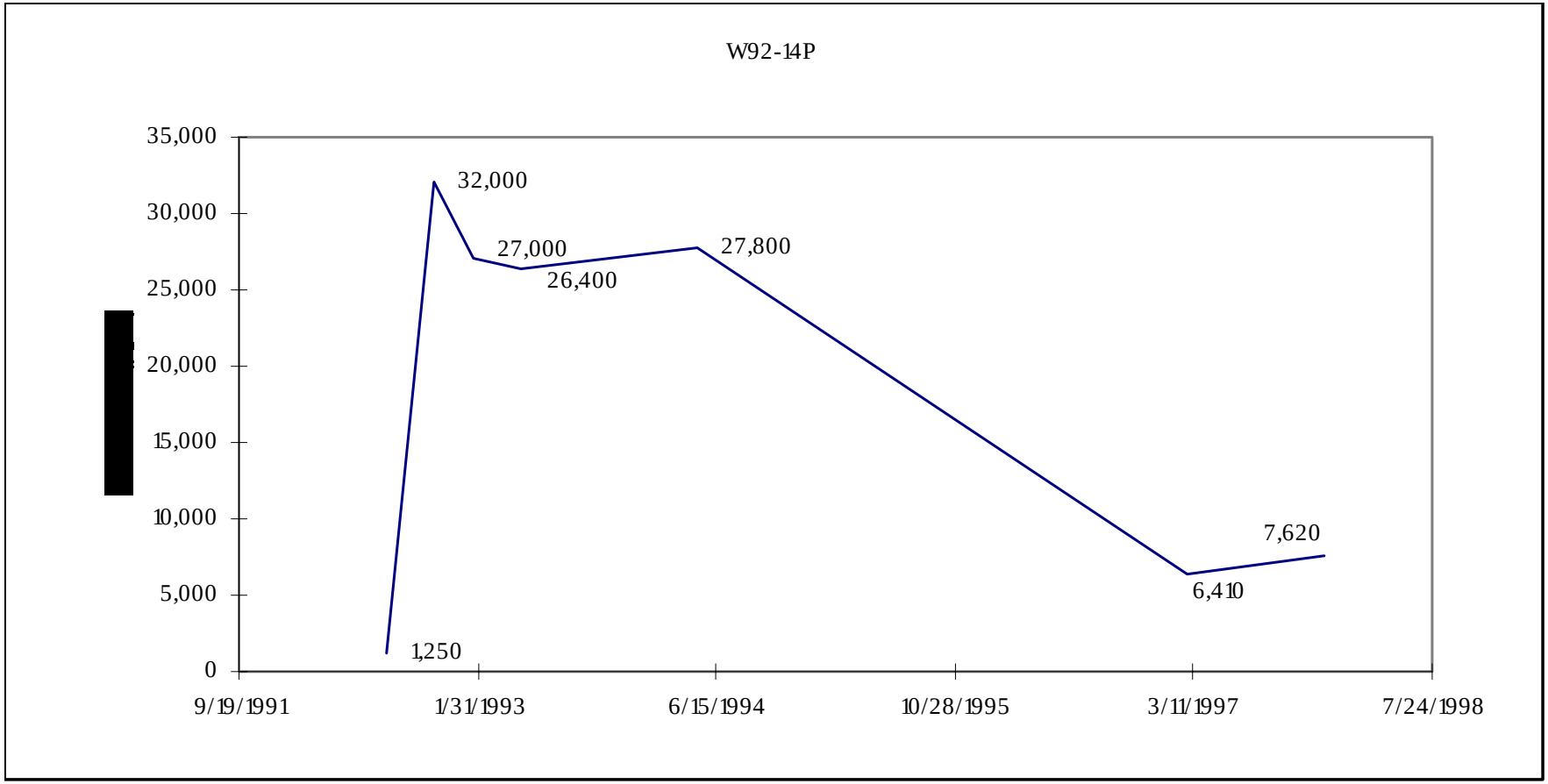
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W92-14A

FIGURE
17

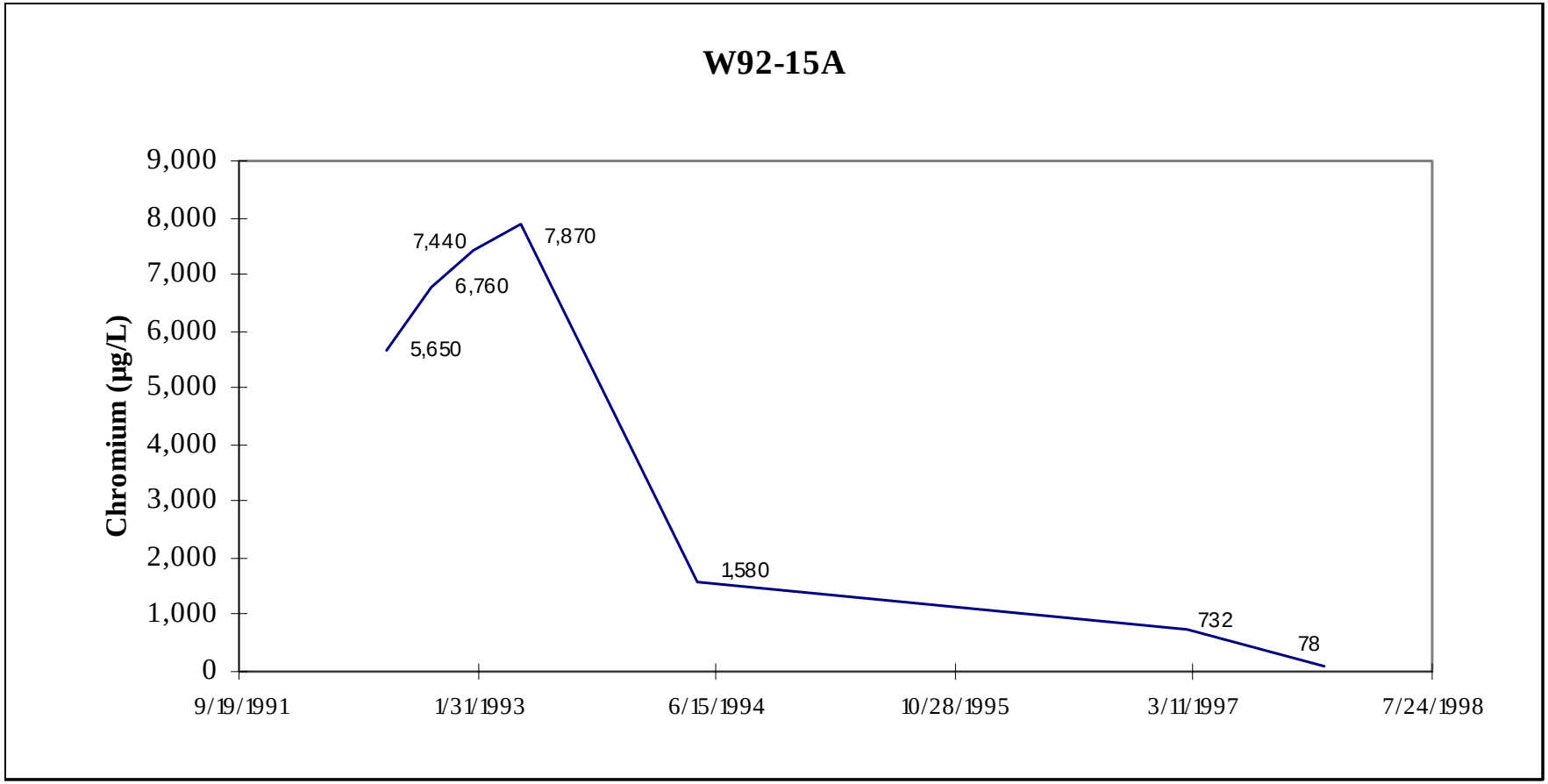
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W92-14P

FIGURE
18

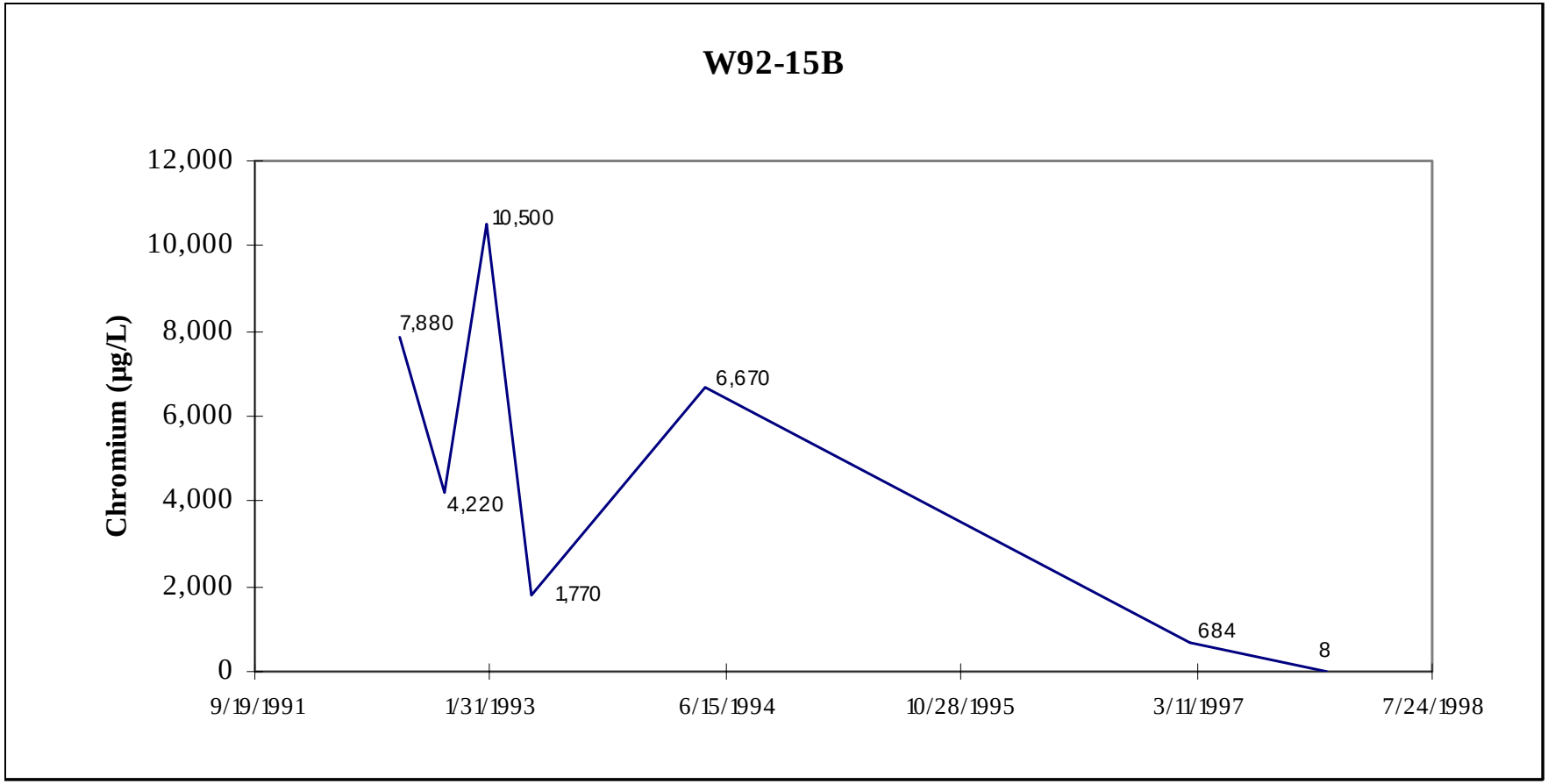
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W92-15A

FIGURE
19

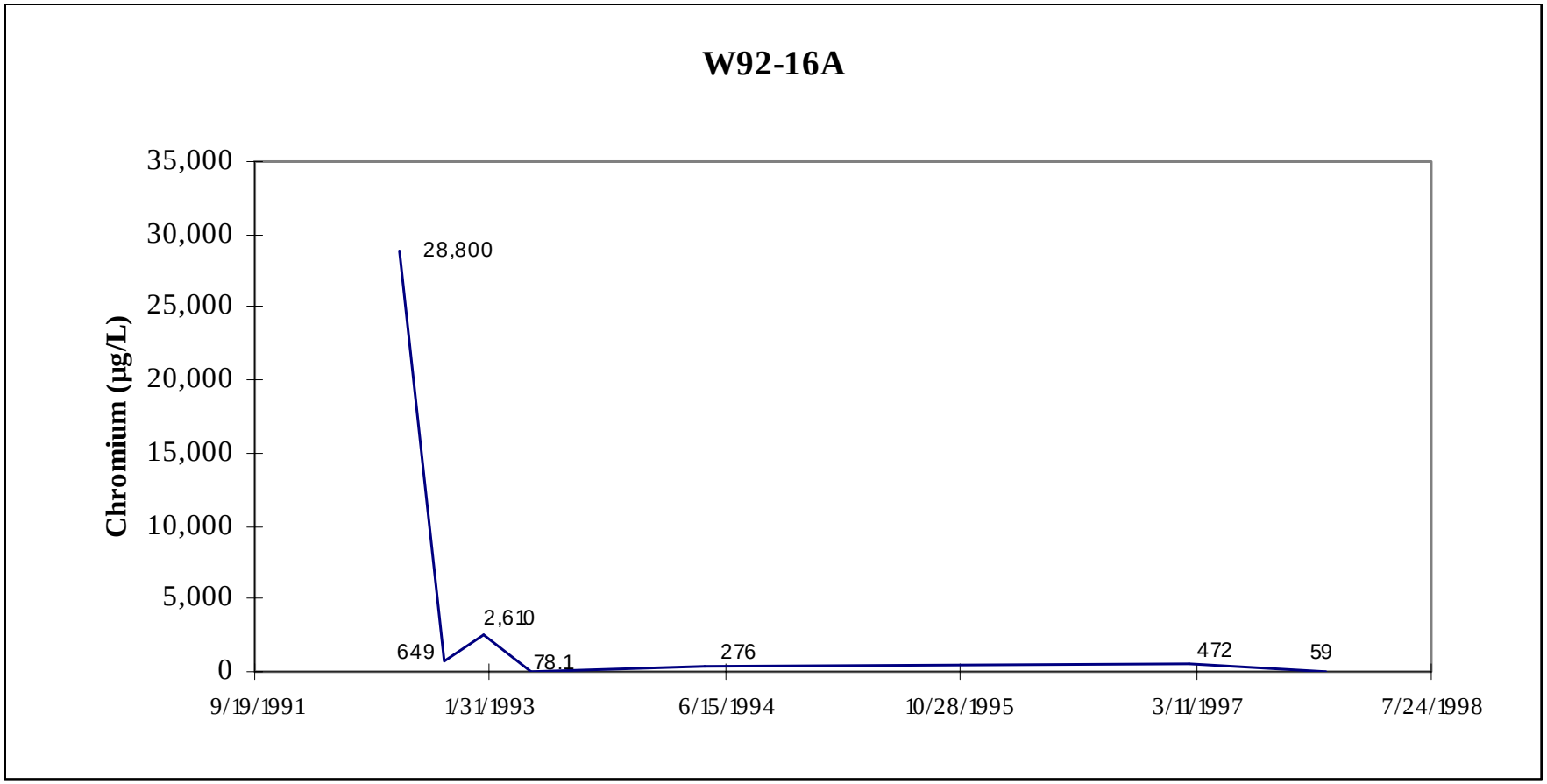
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W92-15B

FIGURE
20

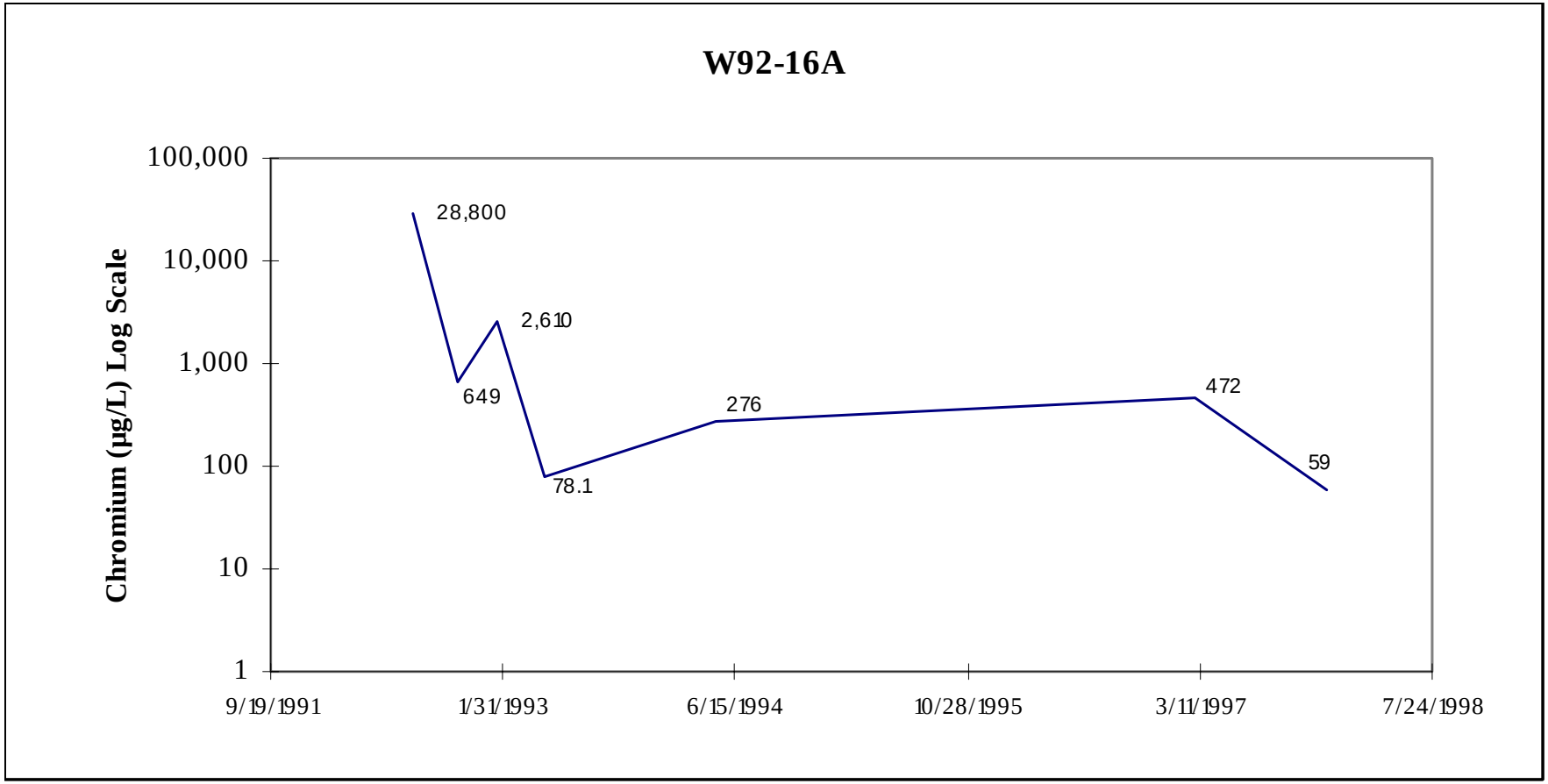
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W92-16A

FIGURE
21

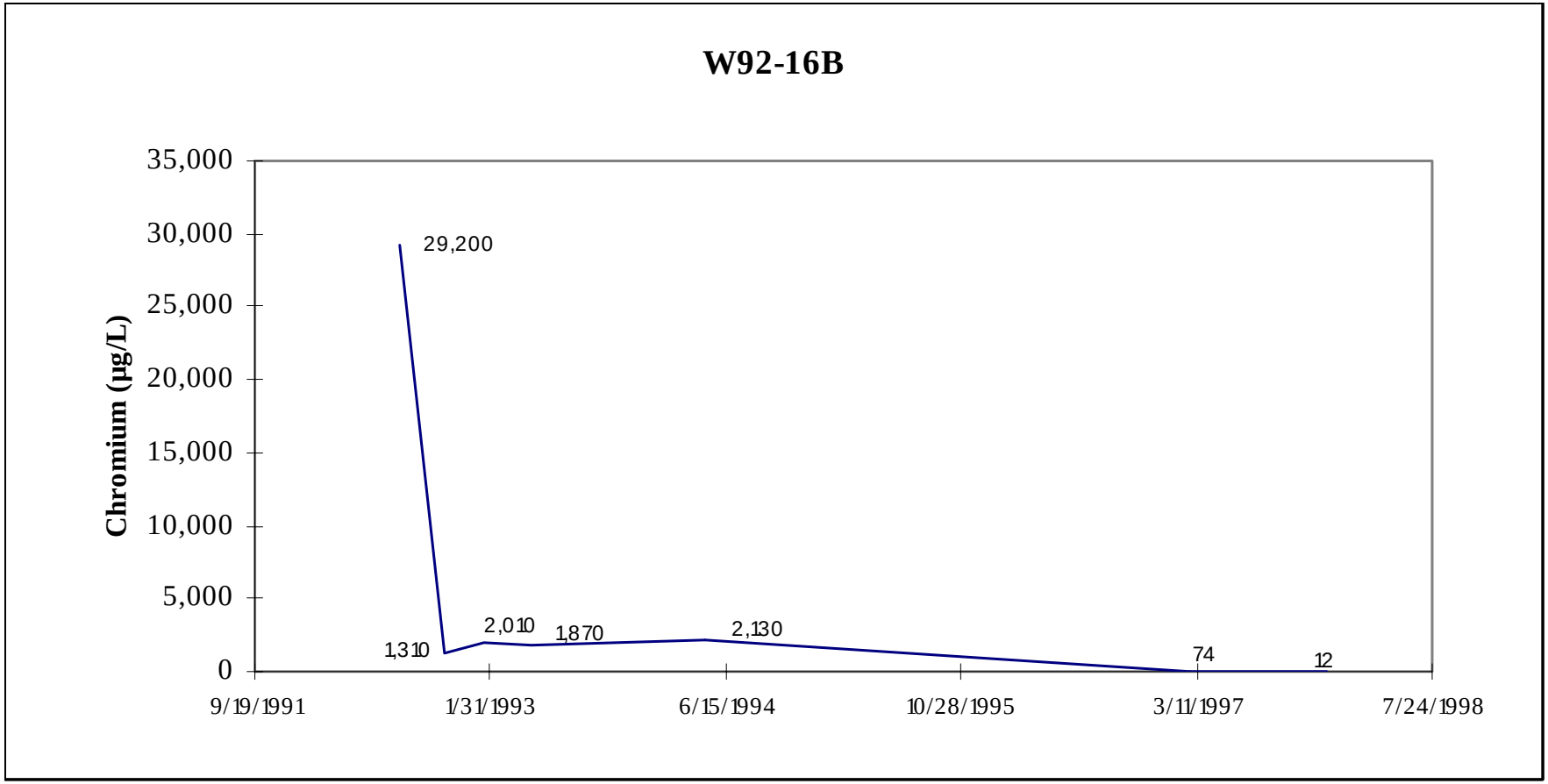
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W92-16A

FIGURE
22

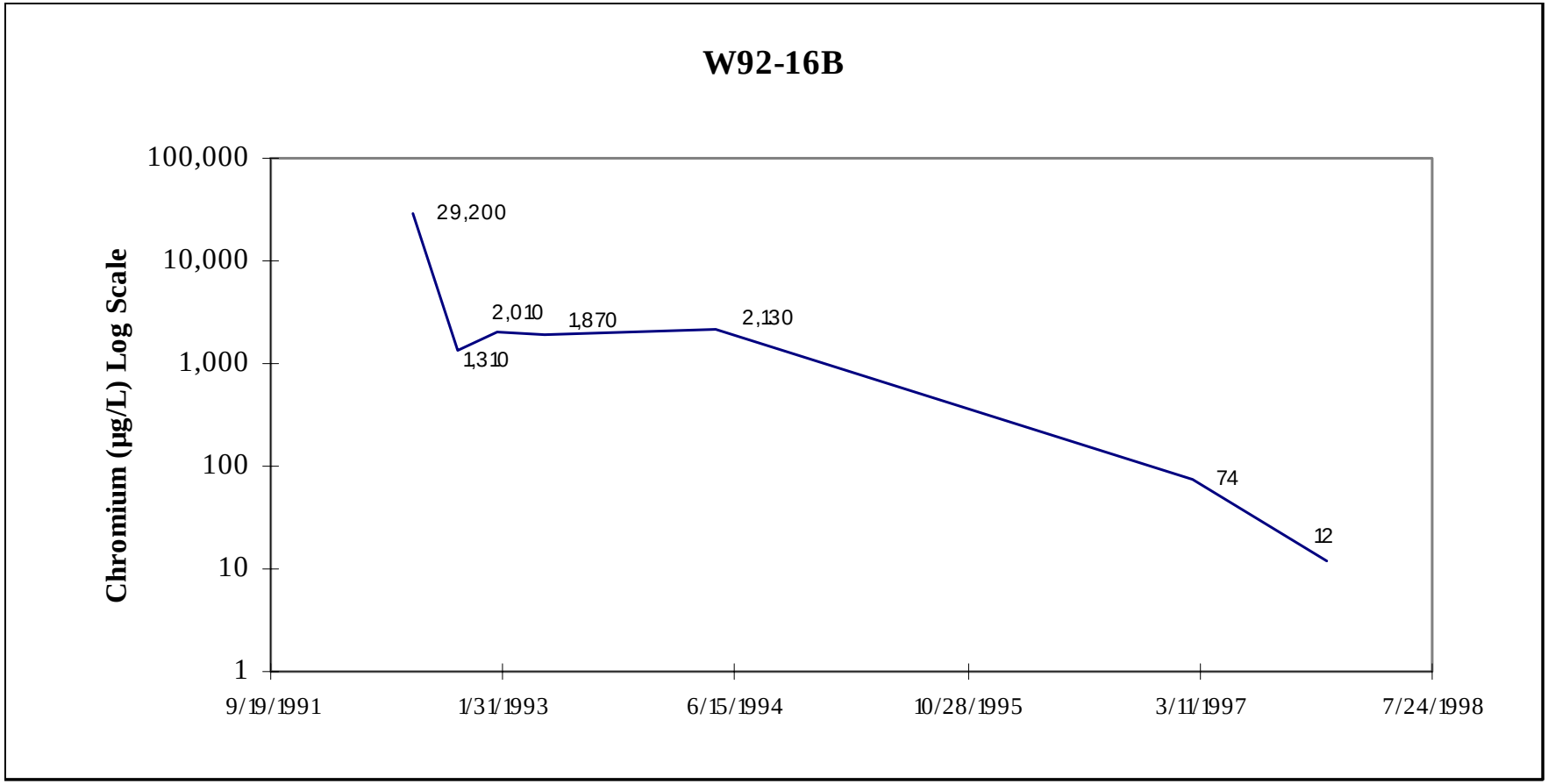
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W92-16B

FIGURE
23

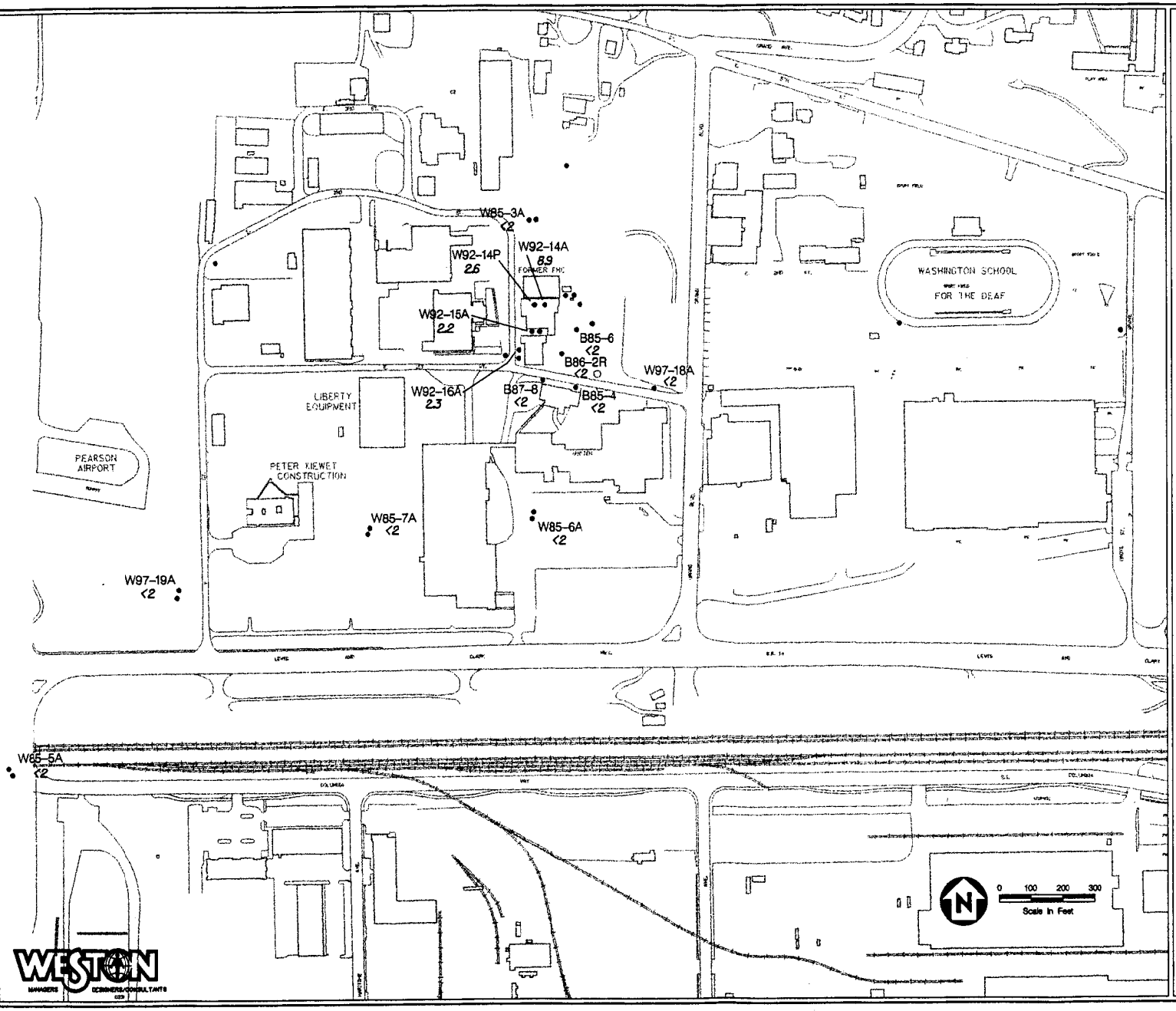
98-0247.ppt



Frontier Hard Chrome
Unfiltered Chromium Concentrations - Well W92-16B

FIGURE
24

98-0247.ppt



EXPLANATION

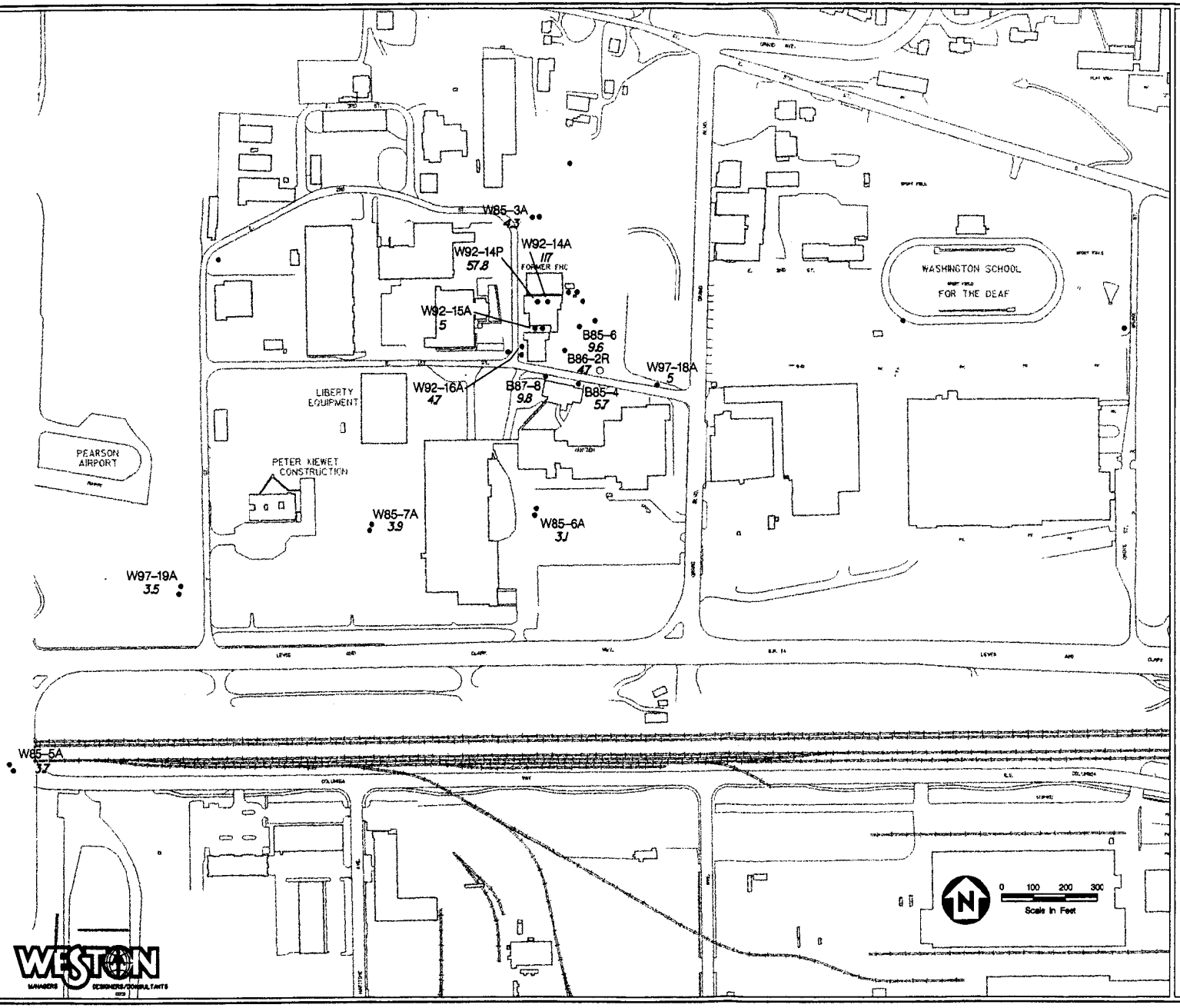
W85-3A
<2 • Monitoring Well and December 1997 Total Cadmium Concentration (ug/L)

Frontier Hard Chrome
Unfiltered Cadmium Concentration
in Groundwater
Perched and "A" Zone Aquifers
December 1997

FIGURE
25

WESTON MANAGERS ENGINEERS/CONSULTANTS

nfsdir/1998jobs/98-0247/fig25.dgn



EXPLANATION

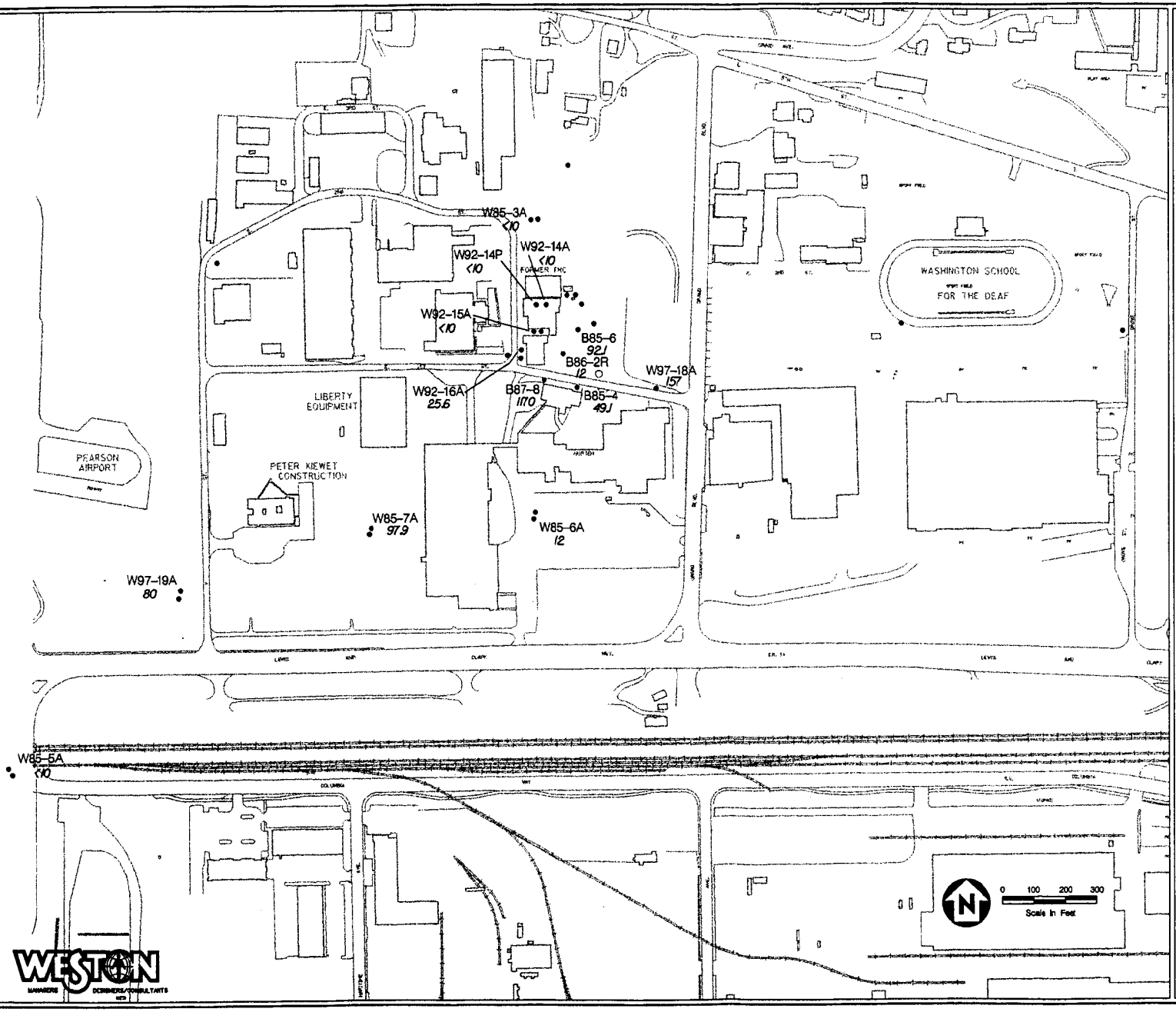
W85-3A
4.3
• Monitoring Well and December 1997 Total Copper Concentration (ug/L)

Frontier Hard Chrome
Unfiltered Copper Concentration
in Groundwater
Perched and "A" Zone Aquifers
December 1997

FIGURE
26

WESTON MANAGERS DESIGNERS/CONSULTANTS

nfsdir/1998jobs/98-0247/fig26.dgn



EXPLANATION

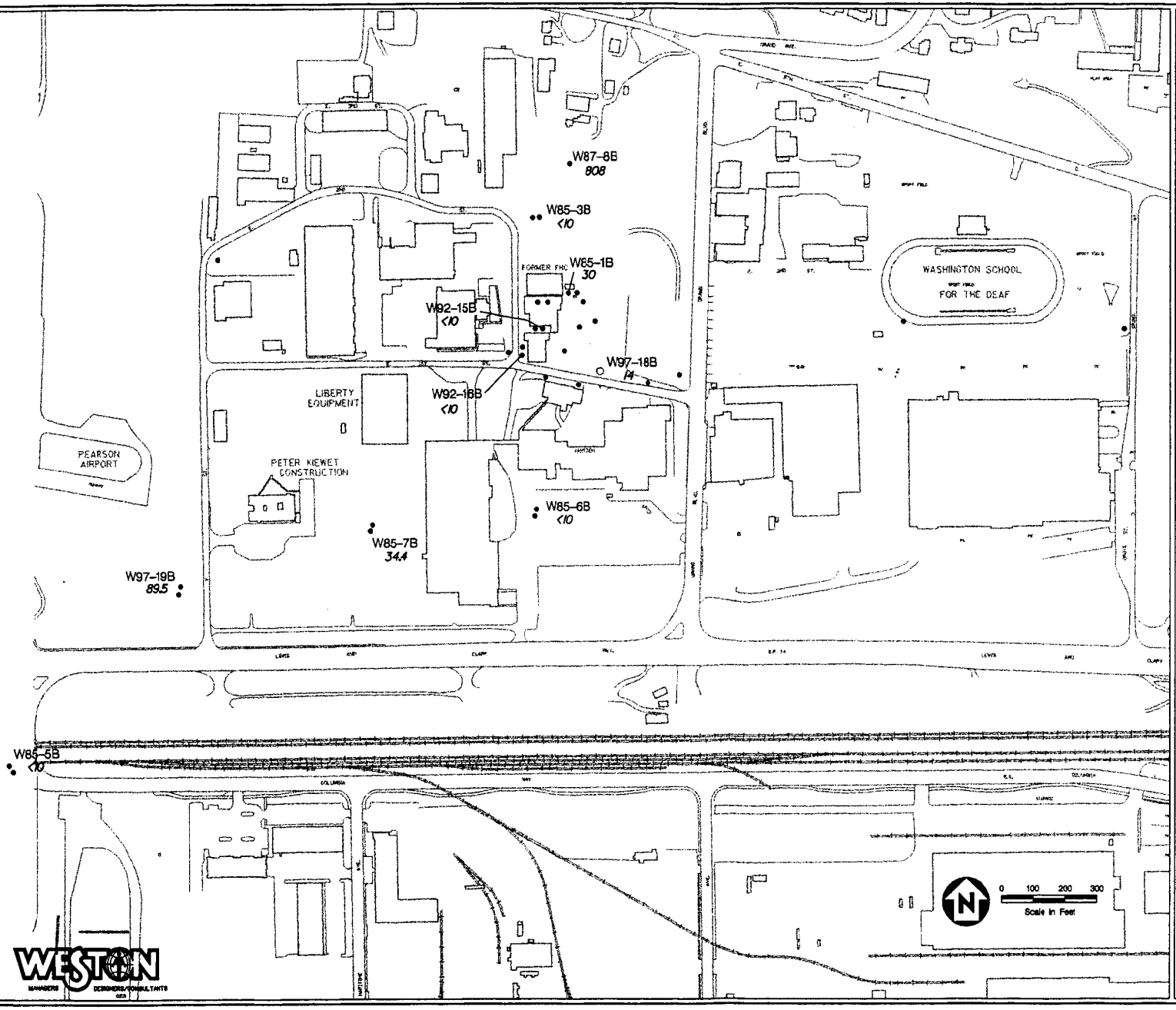
W85-3A
<10
Monitoring Well and December 1997 Dissolved Iron Concentration (ug/L)

Frontier Hard Chrome
Filtered Iron Concentration
in Groundwater
Perched and "A" Zone Aquifers
December 1997

FIGURE
27

WESTON MANAGERS ENGINEERS/CONSULTANTS

nfsdir/1998jobs/98-0247/fig27.dgn



EXPLANATION

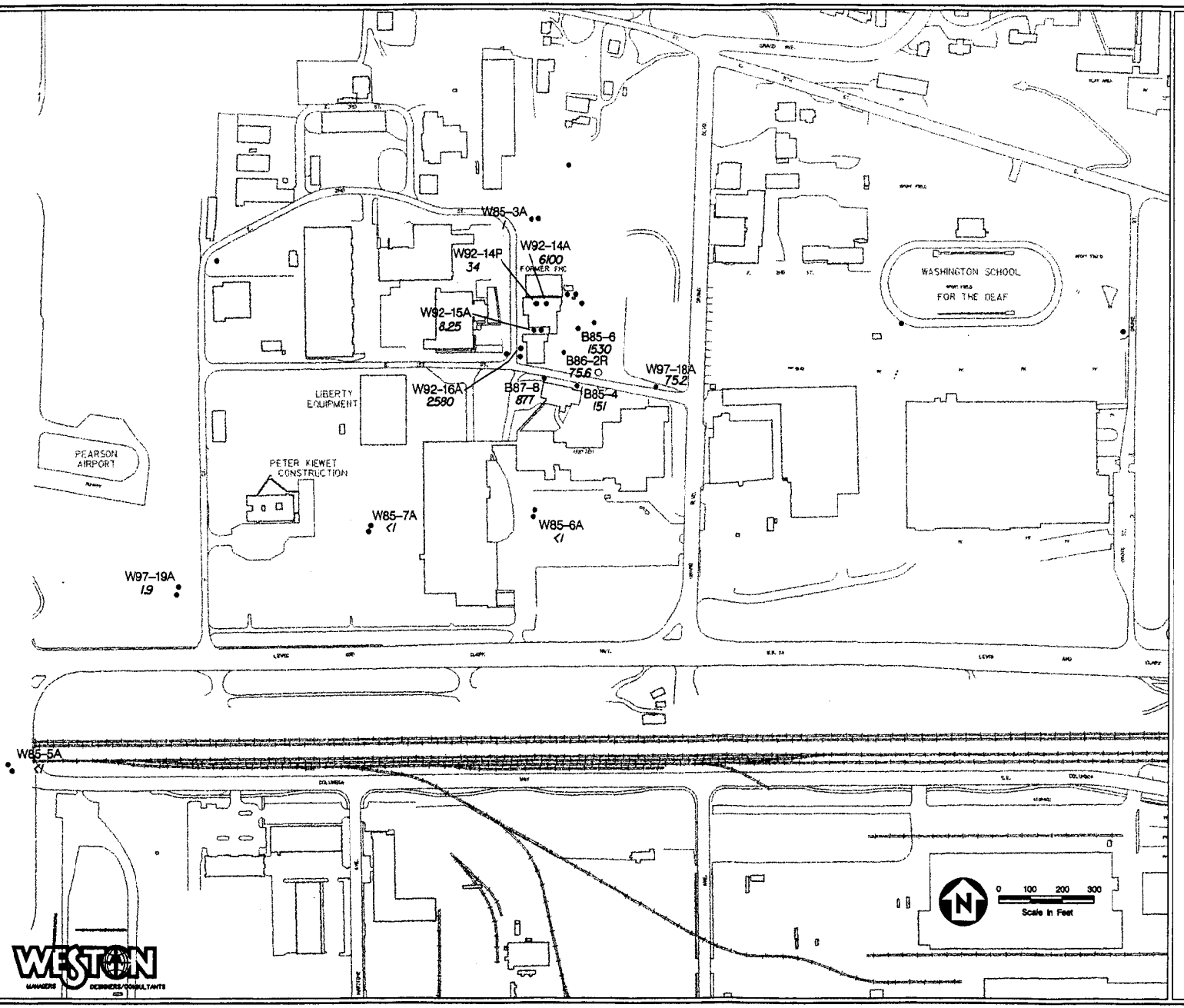
W85-7B
34.4 • Monitoring Well and December 1997 Dissolved Iron Concentration (ug/L)

Frontier Hard Chrome Filtered Iron Concentration in Groundwater "B" Zone Aquifer December 1997

FIGURE
28

WESTON MANAGERS DESIGNERS/CONSULTANTS

nfsdir/1998jobs/98-0247/fig28.dgn



EXPLANATION

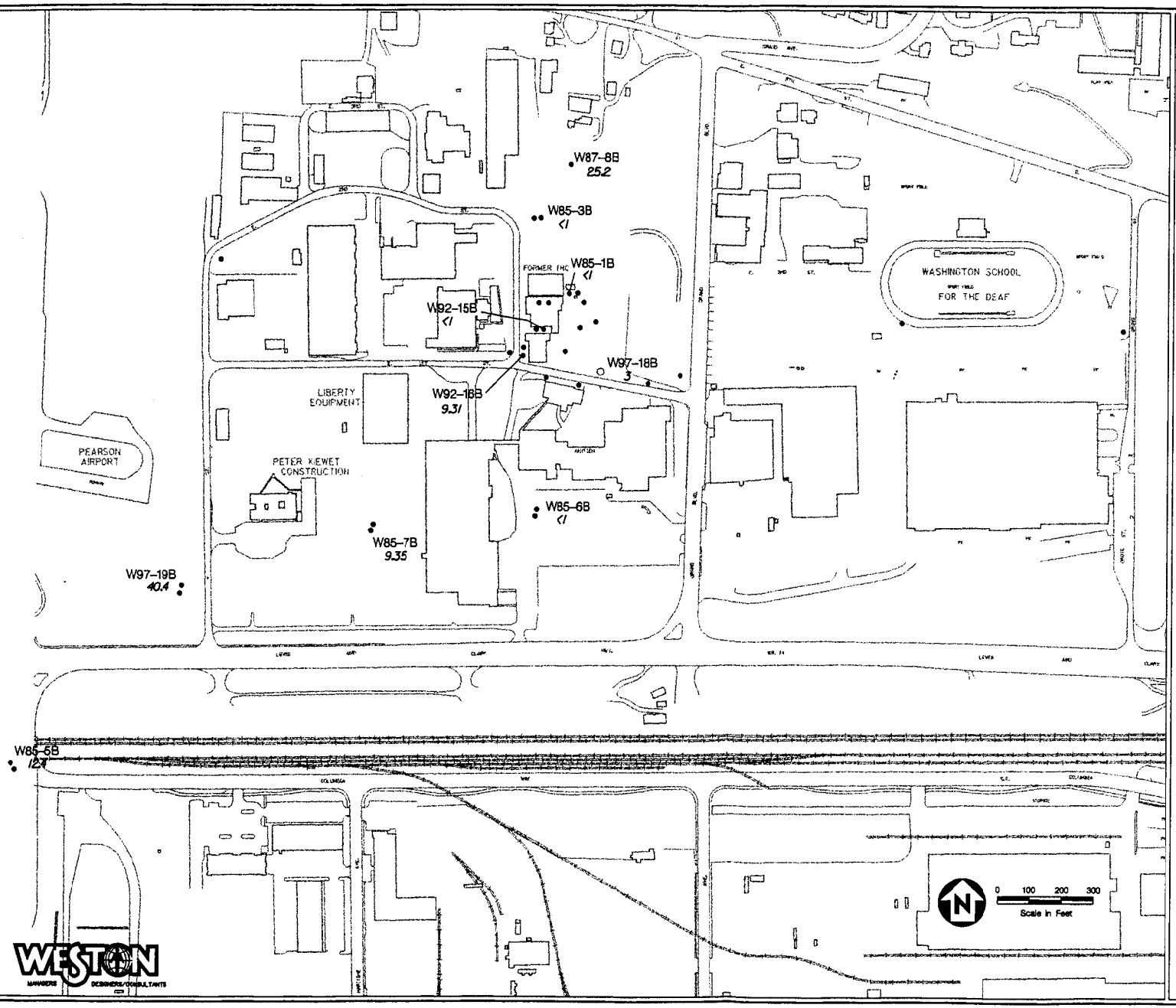
W85-3A / • Monitoring Well and December 1997 Dissolved Manganese Concentration (ug/L)

Frontier Hard Chrome
Filtered Manganese Concentration
in Groundwater
Perched and "A" Zone Aquifers
December 1997

FIGURE
29

WESTON MANAGERS DESIGNERS/CONSULTANTS

nfsdir/1998jobs/98-0247/fig29.dgn



EXPLANATION

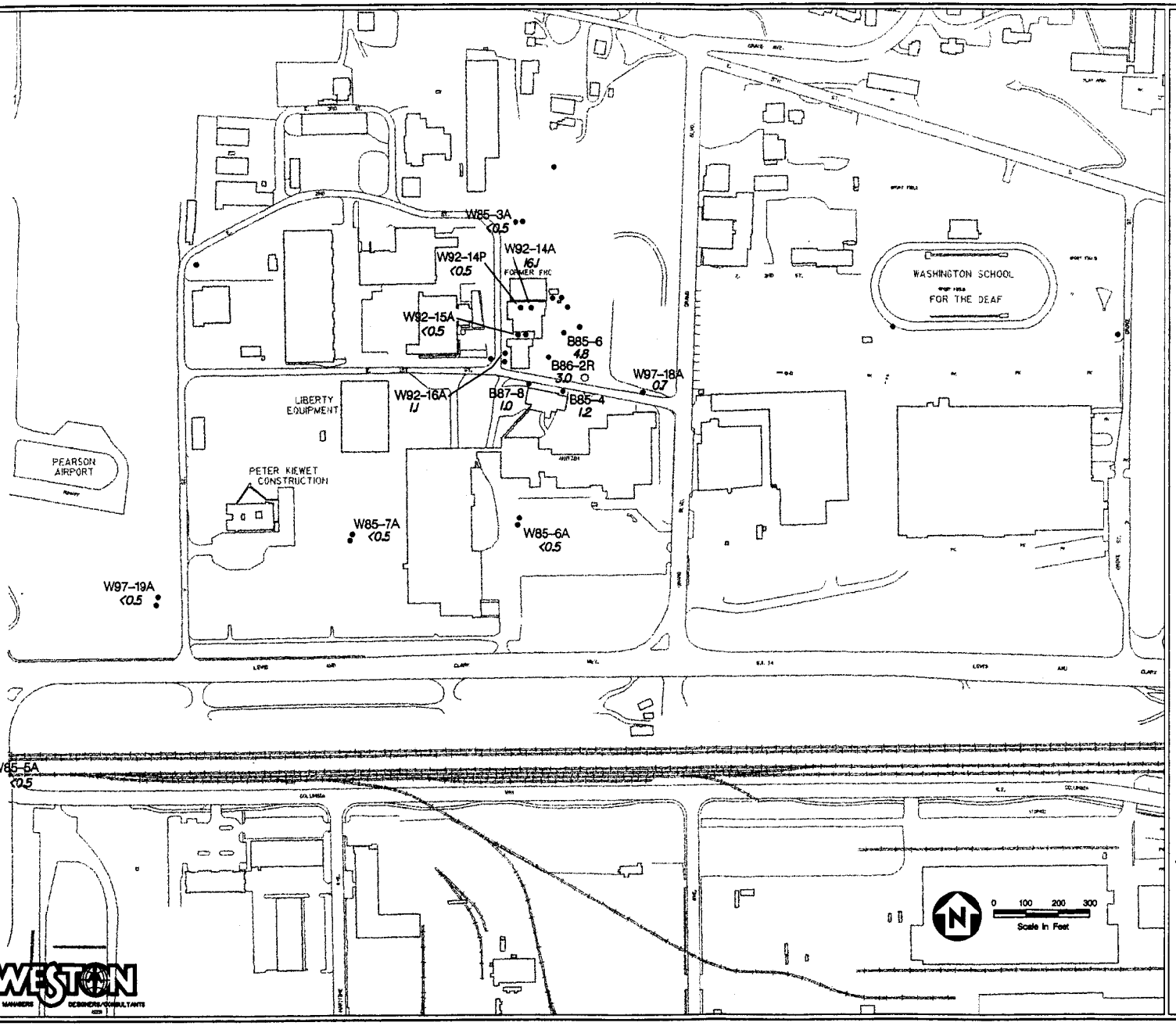
W85-7B
9.35 • Monitoring Well and December 1997 Dissolved Manganese Concentration (ug/L)

Frontier Hard Chrome
Filtered Manganese Concentration
in Groundwater
"B" Zone Aquifer
December 1997

FIGURE
30

WESTON MANAGERS DESIGNERS/CONSULTANTS

nfsdir/1998jobs/98-0247/fig30.dgn



EXPLANATION

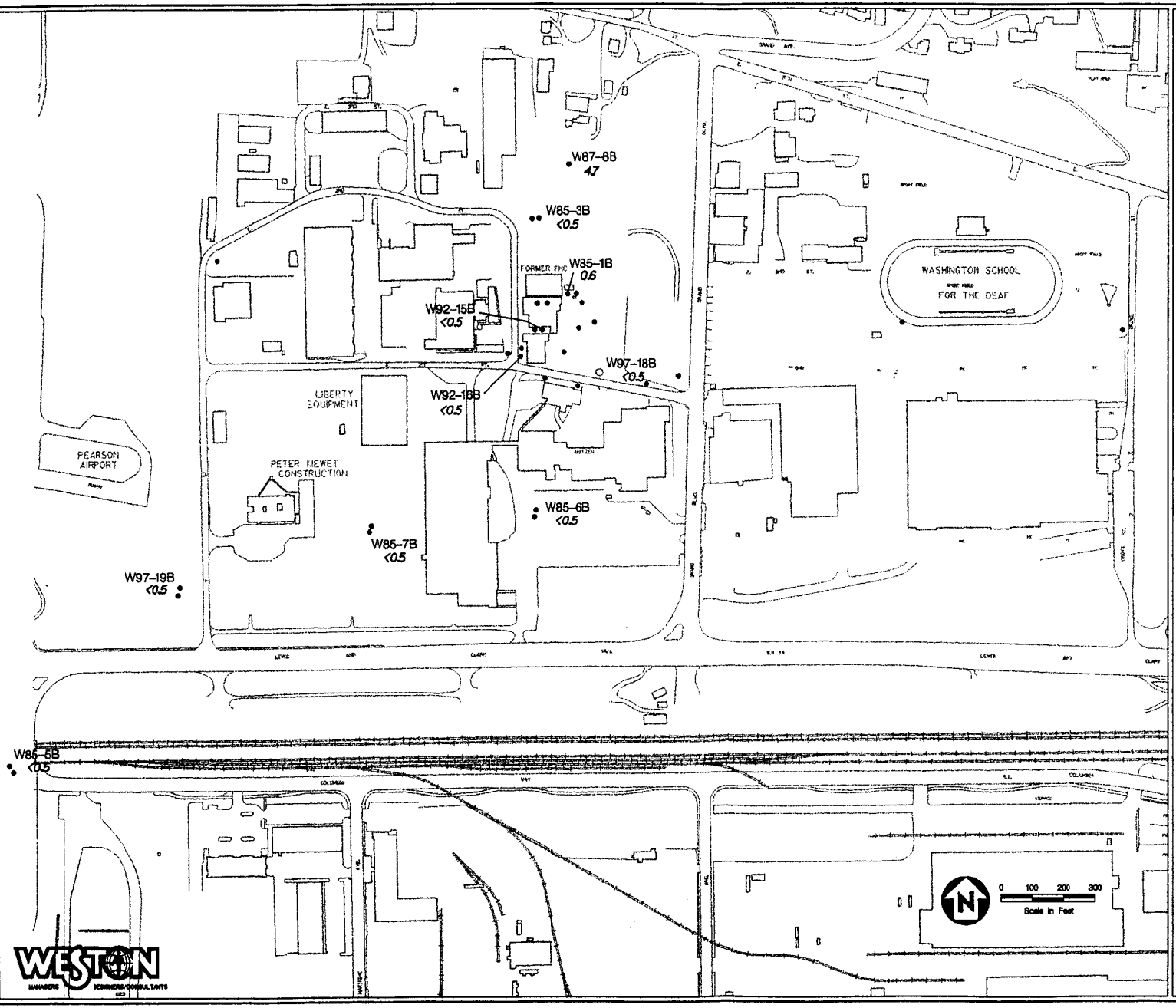
W85-3A
<0.5
Monitoring Well and December 1997 Total Organic Carbon Concentration (mg/L)

Frontier Hard Chrome
Total Organic Carbon Concentration
in Groundwater
Perched and "A" Zone Aquifers
December 1997

FIGURE
31

WESTON MANAGERS DESIGNERS/CONSULTANTS

nfsdir/1998jobs/98-0247/fig31.dgn



EXPLANATION

W85-7B
<0.5 • Monitoring Well and December 1997 Total Organic Carbon Concentration (mg/L)

Frontier Hard Chrome
Total Organic Carbon Concentration
in Groundwater
"B" Zone Aquifer
December 1997

FIGURE
32

nfsdir/1998jobs/98-0247/fig32.dgn

TABLES

Table 1—Groundwater Analytical Program-December 1997

Well Designation	Sample ID	Filtered Chromium	Filtered Hexavalent Chromium	Total Organic Carbon	Unfiltered Metals	Filtered Iron	Filtered Manganese
B85-4	GWR2-B854-0	X	X	X			
B85-6	GWR2-B856-0			X	X	X	X
B86-2R	GWR2-B862R-0			X	X	X	X
B87-8	GWR2-B87R-0	X	X	X	X	X	X
W85-1B	GWR2-W851B-0			X	X	X	X
W85-3A	GWR2-W853A-0			X	X	X	X
W85-3B	GWR2-W853B-0			X	X	X	X
W85-5A	GWR2-W855A-0			X	X	X	X
W85-5B	GWR2-W855B-0			X	X	X	X
W85-6A	GWR2-W856A-0	X	X	X	X	X	X
W85-6B	GWR2-W856B-0	X	X	X	X	X	X
W85-7A	GWR2-W857A-0	X	X	X	X	X	X
W85-7B	GWR2-W857B-0	X	X	X	X	X	X
W87-8B	GWR2-W858B-0			X	X	X	X
W92-14A	GWR2-W8514A-0	X	X	X	X	X	X
W92-14P	GWR2-W8514P-0	X	X	X	X	X	X
W92-15A	GWR2-W8515A-0	X	X	X	X	X	X
W92-15B	GWR2-W8515B-0	X	X	X	X	X	X
W92-16A	GWR2-W8516A-0	X	X	X	X	X	X
W92-16B	GWR2-W8516B-0	X	X	X	X	X	X
W97-18A	GWR2-W8518A-0			X	X	X	X
W97-18B	GWR2-W8518B-0			X	X	X	X
W97-19A	GWR2-W8519A-0			X	X	X	X
W97-19B	GWR2-W8519B-0			X	X	X	X

Table 2—Field Groundwater Quality Parameters

Groundwater Wells	pH	Conductivity (μS)	Temperature (°C)	Redox (mV)	Color/Tubidity (NTU)	Dissolved Oxygen (mg/L)
Sampled Wells						
B85-4	6.5	365	13.9	279	151	1.4
B85-6	6.5	579	13.0	282	120	0.3
B86-2R	6.3	486	13.3	288	240	0.1
B87-8	6.5	257	14.0	273	115	0.2
W85-1B	6.8	246	12.5	312	67	1.8
W85-3A	6.2	386	14.1	179	538	0.6
W85-3B	6.6	265	13.0	194	147	6.9
W85-5A	6.5	242	14.0	283	106	0.4
W85-5B	6.6	256	13.3	287	20	0.6
W85-6A	6.5	267	14.6	301	10	1.6
W85-6B	6.8	265	13.2	315	26	3.0
W85-7A	6.5	114	13.4	306	23	1.6
W85-7B	6.9	30	12.0	289	644	2.8
W87-8B	7.5	94	12.9	255	135	--
W92-14A	6.1	333	13.7	309	30	0.1
W92-14P	5.0	71	15.0	321	4	0.1
W92-15A	6.7	242	13.1	227	62	4.5
W92-15B	6.7	249	12.8	216	210	6.4
W92-16A	6.7	292	13.4	276	361	0.0
W92-16B	6.8	261	13.1	278	119	0.2
W97-18A	6.3	186	14.2	246	99	0.1
W97-18B	6.9	297	13.1	244	214	0.9
W97-19A	6.6	225	13.4	285	86	0.8
W97-19B	6.8	284	12.9	287	27	0.3

Table 3—Chromium Concentrations in Groundwater (µg/L) December 1997

Station ID	Unfiltered Chromium	Filtered Chromium	Filtered Chromium(VI)
B85-4	2,050	2,280	2,170
B85-6	351	NA	NA
B86-2R	13,600	NA	NA
B87-8	706	610	554
W85-1B	11	NA	NA
W85-3A	6.5	NA	NA
W85-3B	5U	NA	NA
W85-5A	5U	NA	NA
W85-5B	22.3	NA	NA
W85-6A	212	200 UJ	214 JH
W85-6B	8.9	40 UJ	5 UJH
W85-7A	9	90 U	18
W85-7B	9.8	110 UJ	9 JH
W87-8B	11	NA	NA
W92-14A	22,600	24600 J	23,200
W92-14P	7,620	7750 J	7,790
W92-15A	78	60 UJ	43
W92-15B	8	120 UJ	7U
W92-16A	59	40 UJ	67
W92-16B	12	100 UJ	5U
W97-18A	5 U	NA	NA
W97-18B	5 U	NA	NA
W97-19A	11	NA	NA
W97-19B	10	NA	NA

NA - not analyzed

Table 4—Metals Concentrations in Groundwater (µg/L)—December 1997

Well Designation	Unfiltered												Filtered Iron	Filtered Manganese
	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Nickel	Selenium	Silver	Thallium	Zinc		
B85-4	<45	<40	<1	<2	2050	5.7	<25	<10	<100	4.5	<40	5.2	49.1	151
B85-6	<45	<40	<1	<2	351	9.6	<25	<10	<100	<4	<40	25.1	92.1	1530
B86-2R	74	<40	<1	<2	13600	4.7	<25	<10	<100	<4	<40	8.7	12	75.6
B87-8	<45	<40	<1	<2	706	9.8	<25	<10	<100	<4	<40	11	1170	877
W85-1B	48	<40	<1	2	11	6.2	<25	<10	<100	<4	<40	42	30	<1
W85-3A	49	<40	<1	<2	6.5	4.3	<25	<10	<100	<4	<40	<4	<10	1
W85-3B	<45	<40	<1	<2	<5	3.3	<25	<10	<100	<4	48	<4	<10	<1
W85-5A	<45	<40	<1	<2	<5	3.7	<25	<10	<100	<4	<40	<4	<10	<1
W85-5B	53	<40	<1	<2	22.3	<3	<25	<10	<100	<4	42	<4	<10	12.4
W85-6A	56	<40	<1	<2	212	3.1	<25	<10	<100	<4	52	<4	12	<1
W85-6B	51	<40	<1	<2	8.9	3.9	<25	<10	<100	<4	49	4.8	<10	<1
W85-7A	50	<40	<1	<2	9	3.9	<25	<10	<100	<4	<40	8.9	97.9	<1
W85-7B	71	61	<1	4.3	9.8	17	<25	<10	<100	<4	67	80.3	34.4	9.35
W87-8B	<45	<40	<1	2.3	11	12.8	<25	<10	<100	<4	<40	41.1	808	25.2
W92-14A	<45	<40	<1	8.9	22600	117	<25	20	<100	<4	<40	112	<10	6100
W92-14P	58	<40	<1	2.6	7620	57.8	<25	<10	<100	<4	<40	14	<10	34
W92-15A	68	<40	<1	2.2	78.2	5	<25	<10	<100	<4	<40	6.4	<10	8.25
W92-15B	<45	<40	<1	2	8	<3	<25	<10	<100	<4	<40	5.6	<10	<1
W92-16A	52	<40	<1	2.3	59.2	4.7	<25	<10	<100	<4	<40	4.3	25.6	2580
W92-16B	50	<40	<1	2.6	12	<3	<25	<10	<100	<4	<40	27	<10	9.31
W97-18A	52	<40	<1	<2	<5	<3	26	<10	<100	<4	<40	7.2	157	75.2
W97-18B	48	<40	<1	<2	<5	<3	<25	<10	<100	<4	<40	7.4	14	3
W97-19A	<45	<40	<1	<2	11	<3	<25	<10	<100	<4	67	6	80	1.9
W97-19B	<45	<40	<1	<2	10	<3	27	<10	<100	<4	<40	13	89.5	40.4

Table 5—Total Organic Carbon Concentrations in Groundwater (mg/L) December 1997

Station ID	TOC
B85-4	1
B85-6	5
B86-2R	3
B87-8	1
W85-1B	0.6
W85-3A	<0.5
W85-3B	<0.5
W85-5A	<0.5
W85-5B	<0.5
W85-6A	<0.5
W85-6B	<0.5
W85-7A	<0.5
W85-7B	<0.5
W87-8B	4.7
W92-14A	16
W92-14P	<0.5
W92-15A	<0.5
W92-15B	<0.5
W92-16A	1
W92-16B	<0.5
W97-18A	0.7
W97-18B	<0.5
W97-19A	<0.5
W97-19B	<0.5

APPENDIX A

FIELD METHODOLOGY

APPENDIX A

FIELD METHODOLOGY

This appendix summarizes the field methodology used by WESTON to conduct its groundwater sampling activities. All field activities were conducted in general accordance with a Sampling and Analysis Plan prepared by WESTON (dated 22 January 1997). Specific elements of the sample collection tasks are discussed below.

GROUNDWATER ELEVATIONS

The depth to groundwater table relative to the monitoring well casing as measured in each well. Water level measurements were taken using an electronic water level indicator interface probe. The probe was cleaned between each well measurements with an Alconox wash and a distilled water rinse.

GROUNDWATER SAMPLING

The monitoring wells were purged and sampled using a peristaltic pump. The tubing was lowered slowly into the well to minimize disturbance and down to the center of the screen and at least 2 feet above the bottom of the well during purging. The wells were purged at low pumping rate to minimize drawdown until the field parameters (temperature, conductivity, pH, redox and dissolved oxygen) were stabilized. All field parameter measurements were obtained using water quality meters with a flow-through-cell. Turbidity was also monitored during purging. Water was diverted into a clean container and the turbidity of the water sample was measured with a hand held turbidity meter in NTUs.

Water samples were taken directly from the peristaltic pump tubing after removing the water quality meter flow-through-cell and placed into a bottle and preserved. Samples for filtered metals analysis were filtered in the field using a flow-through-disposable 0.45 µm filter.

ANALYTICAL METHODS

Except for filtered chromium, filtered hexavalent chromium and total organic carbon, all groundwater samples were analyzed by EPA's Manchester Laboratory. Filtered chromium, filtered hexavalent chromium, and total organic carbon were analyzed by Columbia Laboratory of Kelso, Washington.

APPENDIX B

LABORATORY QA/QC REPORTS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10 LABORATORY
7411 Beach Dr. East
Port Orchard, Washington 98366

MEMORANDUM

DATE: February 5, 1998

TO: Sean Sheldrake, Project Manager, EPA Region 10
Bernie Zavala, Project Manager, EPA Region 10

FROM: Katie Adams, Chemist, EPA Region 10 K. Adams
Manchester Environmental Laboratory

SUBJECT: Quality Assurance Review of Frontier Hardchrome - Total Metals
Sample Numbers: 97504401 - 97504449
Project Code: TEC-410D

CC: Roger McGinnis, Roy F. Weston

The following is a quality assurance review of the total metals analysis of twenty-five (25) water samples from the Frontier Hard Chrome site. The analyses were done following USEPA and laboratory guidelines by the ESAT Team at the USEPA Manchester Environmental Laboratory, Port Orchard, WA. This quality assurance review was conducted for the following samples:

Samples

97504401	97504403	97504405	97504407	97504409
97504411	97504413	97504415	97504417	97504419
97504421	97504423	97504425	97504427	97504429
97504431	97504433	97504435	97504437	97504439
97504441	97504443	97504445	97504447	97504449

Data Qualifications

The following comments refer to the ESAT performance in meeting quality control specifications outlined in the *CLP Statement of Work (CLP-SOW) for Inorganic Analysis, rev. ILMO4.0,* the *Manchester Environmental Laboratory Quality Assurance Manual, rev. 5/88,* and the QAPP.

1.0 Timeliness - Acceptable

The technical (40 CFR part 136) holding time from the date of collection for mercury and metals in water is 28 and 180 days, respectively. Sample collection began on 12/08/97. Mercury analysis was completed on 12/16/97. The ICP-AES analysis was completed on 12/17/97. No qualification was required based on holding time criteria.

2.0 Sample Preparation - Acceptable

The samples were prepared for mercury analysis on 12/15/97. The samples were prepared for ICP-PP analysis based on Method ILM04.0 on 12/16/97. All sample preparation was by the Manchester Laboratory protocols. No data qualification was required based on sample preparation.

3.0 Calibrations - Acceptable

All samples were analyzed for mercury by CVAAS on 12/16/97. Initial calibration included one blank and at least four standards. The curve was linear with a correlation coefficient greater than 0.995.

ICP-AES (Inductively Coupled Plasma - Atomic Emission Spec) analysis was conducted on 12/17/97 (silver, arsenic, beryllium, cadmium, chromium, copper, nickel, lead, antimony, selenium, thallium, and zinc). The instrument was standardized using one blank and a single calibration standard for each element.

All calibrations were done as required and met the acceptance criteria; therefore, no data was qualified.

4.0 Reference Control Samples/Calibration Verification - Acceptable

Calibration verification samples are required before and after sample analysis and after every ten samples during analysis. Mercury recoveries must be within 80-120%. Other metal recoveries must be within 90-110%.

All ICP-AES and CVAAS (mercury) calibration verification (initial and continuing) samples met the recovery criteria. Calibration verification samples were analyzed after every ten samples. No qualification was required based on ICP-AES and CVAAS (mercury) calibration verification.

The analysis of the final PQL resulted in arsenic exceeding the recovery criteria. The final integration of four burns was an outlier and does not significantly affect the quality of the reported data. No qualification is required based on PQL analysis.

Reference control samples are digested and analyzed along with the samples to verify the efficiency of laboratory procedures. All recoveries met the acceptance criteria for control samples and no qualifiers were required on this basis.

5.0 Blanks

Procedural blanks were prepared with the samples to show potential contamination from the digestion or analytical procedure. If an analyte was found in the associated blank, the sample results were qualified if the analyte concentration was less than ten times the analytical value in the blank.

The analysis of the procedural blank prepared with samples 97504441, 97504443, 97504445, 97504447, and 97504449 resulted in a detectable level of lead. The result appeared to be due to instrument noise rather than contamination. The detection limit for this set of samples was elevated from 25 ppb to 27 ppb for lead in order to compensate for the higher level of background variation. All remaining ICP-AES procedural blank results and continuing calibration blanks surrounding the samples met the acceptance criteria. No qualification was required based on blank analysis.

6.0 ICP-AES Interference Check Sample - Acceptable

The interference check sample (ICS) is analyzed by ICP-AES to verify interelement and background correction factors. Analysis is required at the beginning and end of each sample analysis run and recoveries must be between 80% and 120%. All ICS recoveries were within the recovery criterion. No data qualification was required based on ICP-AES interference check sample analysis.

7.0 Duplicate Analysis - Acceptable

Duplicate analysis was done on samples 97504411 and 97504441 for CVAAS and ICP-AES. All results above the practical quantitation limit were within the $\pm$20% RPD criterion. No qualification was required based on duplicate analysis.

8.0 Field Duplicate Analysis - Not Applicable

Field duplicate analysis was not shown in the field collection documentation.

9.0 Matrix Spike Analysis - Acceptable

Matrix spike sample analyses are done to provide information about the effect of the sample matrix on digestion and measurement methods. The laboratory limits for matrix spike recovery for digested samples must be within the limits of 75 - 125%.

Matrix spike analysis was done on samples 97504411 and 97504441 for CVAAS and ICP-AES. All matrix spike recoveries were within the specified limits. No qualification was required based on matrix spike analysis.

10.0 Graphite Furnace Atomic Absorption Spec (GFAAS) QC - Not Applicable

GFAAS analysis was not required for this sample set.

11.0 ICP-AES Serial Dilution - Acceptable

Samples 97504421 and 97504443 were analyzed by serial dilution to check for potential interferences in the ICP-AES analysis. All analytes that exceeded the minimum concentration criterion (50 times the MDL) agreed within 10% RPD. No qualification was required on this basis.

12.0 Detection Limits

Sample results that fall below the method detection limit (MDL) are assigned the value of the instrument detection limit and the 'U' qualifier is required for attachment.

13.0 Overall Assessment of the Data

This quality control review of the data is based on the criteria outlined in the *National Functional Guidelines for Inorganic Data Review (02/94)*. No qualification was required for this sample set.

Definitions of laboratory qualifiers are attached.

Below are the definitions for the qualifiers used in the Inorganic area when qualifying data from Inorganic analysis.

DATA QUALIFIERS

U	-	Element was analyzed but not detected. The associated numerical value is the instrument detection limit/method detection limit.
J	-	The associated value is an estimated quantity.
H	-	The samples were analyzed after the suggested holding times.
E	-	The reported value is an estimate because of the presence of interference. An explanatory note will be included with the report.
B	-	Analyte is found in the analytical blank and the sample indicating possible/probable blank contamination. If an analyte is found in any of the associated procedural blanks, the concentration in the samples must be at least ten times the quantity observed in the blank. If the sample result fails these criteria, the sample result is qualified (B).
N	-	Spiked sample recovery not within control limits.
NAR	-	There is no analysis result for this analyte.
NA	-	Not applicable/Not required.

Roy F. Weston, Inc.
Suite 5700
700 5th Avenue
Seattle, Washington 98104-5057
206-521-7600 • Fax 206-521-7601

MEMORANDUM

DATE: 16 February 1998

TO: Sean Sheldrake, WAM, U.S. EPA, Region X

FROM: Jennifer M. Baier, Environmental Chemist, WESTON, Seattle JMB
RMM Roger McGinnis, Senior Environmental Chemist, WESTON, Seattle

SUBJECT: QA of Case K9709046 (dissolved total chromium and dissolved hexavalent chromium)
Site: Frontier Hard Chrome

WORK ASSIGN NO.: 46-38-027N

DOC. CONTROL NO.: 4000-032-001-AABU

WORK ORDER NO.: 4000-032-001-5100-00

cc: Bruce Woods, TPO, U.S. EPA, Region X
Keith Pine, Project Manager, WESTON, Seattle (memo only)

The quality assurance review of 13 samples, Case K9709046, collected from Frontier Hard Chrome has been completed. The groundwater samples were analyzed at low level for dissolved total chromium and dissolved hexavalent chromium by Columbia Analytical Services, of Kelso, WA. The samples were numbered:

97504428	97504426	97504424	97504420	97504422
97504444	97504410	97504412	97504416	97504414
97504448	97504432	97504430		

Data Qualifications

The following comments refer to the laboratory performance in meeting the quality control criteria described in the technical specifications of the laboratory subcontract.

1. Holding Times

All samples met holding time criteria, with the exception of the following:

Sample	Fraction	Collected	Analyzed	QC Limit	Exceeded QC Limit
97504410	hexavalent chromium	12/9/97 8:10 am	12/10/97 10:45 am	24 hrs	2:35 hrs
97504412	hexavalent chromium	12/9/97 9:05 am	12/10/97 10:45 am	24 hrs	1:40 hrs
97504416	hexavalent chromium	12/9/97 10:10 am	12/10/97 10:45 am	24 hrs	35 mins

Sample results were qualified as estimated (JH/UJH).

2. Calibration

a. Initial Calibration

Initial calibration frequencies and QC criteria were met.

b. CRI/CRA Standards

Instrument calibration near the required detection limit was verified and met recovery criteria for all analytes.

c. Initial and Continuing Calibration Verification

All inductively coupled plasma (ICP) results met control limits of 90 to 110 percent recovery (percent R) of the true values for both initial and continuing calibration.

3. Instrument Detection Limits

All instrument detection limits (IDL) for analyses are equal to or less than the required detection limits.

4. Blanks

a. Laboratory Method Blanks

The following analytes were detected in laboratory method blanks.

Blank ID	Analyte	Concentration (mg/L)	Associated Samples
K9709046-MB	Dissolved Total Chromium	0.08	97504428, 97504426, 97504424, 97504420, 97504422, 97504444, 97504410, 97504412, 97504416, 97504414, 97504448, 97504432, 97504430

Blank contamination appears to be associated with permanganate used to oxidize the chromium.

Results for analytes listed above were qualified as undetected (UJ) if concentrations in associated samples were less than five times the concentration present in the blank.

b. Initial Calibration and Continuing Calibration Blanks

No analytes were detected in calibration blanks.

c. Field Blanks

No field blank samples were associated with this sample delivery group.

5. Laboratory Control Sample

The recoveries for all analytes for ICP analysis were within the control limits of 80 to 120 percent for water with the exception of total chromium (139%). Samples analyzed for dissolved total chromium were qualified as estimated if detected.

6. Laboratory Duplicate Sample Analysis

Relative percent difference between laboratory duplicate results exceeded QC limits 20 percent ($\pm$ detection limit for concentrations less than 5 times the detection limit) for water for the following analytes:

Analyte	RPD
Dissolved total chromium	50

Results for the above analytes have been qualified as estimated (J).

7. Spiked Sample Analysis

Matrix spike recoveries for all analytes met QC criteria of 75 to 125 percent.

8. Field Duplicate Analysis

Samples 97504420 and 97504422 were field duplicates. Results exhibited reasonable agreement.

9. Laboratory Contact

The laboratory was contacted to discuss inconsistencies between hexavalent and total chromium results. It was concluded that problems were a result of chromium contamination in the permanganate used in the oxidation step for analysis of total chromium. Results were verified by ICP.

Data Assessment

The usefulness of the data is based on the criteria outlined in the U.S. EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (OSWER 9240.1-05-01).

Upon consideration of the data qualifications noted above, the data are ACCEPTABLE for use except where flagged with data qualifiers that modify the usefulness of the individual values.

Data Qualifiers

U - The material was analyzed for, but was not detected.

UJ - The analyte was not detected. The associated quantitation limit is an estimate because quality control criteria were not met.

J - The analyte was positively identified, but the associated numerical value is an estimated quantity because quality control criteria were not met or because concentrations reported were less than the quantitation or lowest calibration standard.

R - Quality control indicates that data are unusable (compound may or may not be present). Resampling and reanalysis are necessary for verification.

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client:	Roy F. Weston, Inc.	**Service Request:**	K9709046
Project:	04000-032-001-5100-00	**Date Collected:**	12/8-12/10/97
Sample Matrix:	Water	**Date Received:**	12/8-12/10/97
		Date Extracted:	NA

Inorganic Parameters
Units: mg/L (ppm)

Analyte:	**Chromium, Hexavalent**
EPA Method:	7196A
Method Reporting Limit:	0.005
Date Analyzed:	12/9,10/1997

Sample Name		**Lab Code**	
97504428	GWR2-W9215B-0	K9709046-001	0.007
97504426	GWR2-W9215A-0	K9709046-003	0.043
97504424	GWR2-W9214P-0	K9709046-007	7.79
97504420	GWR2-W9214A-0	K9709046-009	23.2
97504422	GWR2-W9214A-1	K9709046-011	0.010
97504444	GWR2-B854-0	K9709046-014	2.17
97504410	GWR2-W856A-0	K9709046-018	0.214 ~~(H)~~ JH
97504412	GWR2-W856B-0	K9709046-020	~~ND~~ ~~(H)~~ 0.005 UJH
97504416	GWR2-W857B-0	K9709046-022	0.009 ~~(H)~~ JH
97504414	GWR2-W857A-0	K9709046-024	0.018
97504448	GWR2-B878-0	K9709046-028	0.554
97504432	GWR2-W9216B-0	K9709046-034	~~ND~~ 0.005 U
97504430	GWR2-W9216A-0	K9709046-037	0.067
Method Blank		K9709046-MB	~~ND~~ 0.005 U

H The Sample was received past the recommended hold time.

Approved By: _____ Date: 1/19/98

gmb 2/3/98

3ADW/061694

C0005

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: Roy F. Weston, Inc.
Project: 04000-032-001-5100-00
Sample Matrix: Water

Service Request: K9709046
Date Collected: 12/8-12/10/97
Date Received: 12/8-12/10/97
Date Extracted: 1/7/98

Inorganic Parameters
Units: mg/L (ppm)

Analyte:	**Chromium, Total**
EPA Method:	3500-CrD
Method Reporting Limit:	0.005
Date Analyzed:	1/7/98

Sample Name	Lab Code	
97504428 GWR2-W9215B-0	K9709046-001	0.12 UJ
97504426 GWR2-W9215A-0	K9709046-003	0.06 UJ
97504424 GWR2-W9214P-0	K9709046-007	7.75 J
97504420 GWR2-W9214A-0	K9709046-009	24.6 J
97504422 GWR2-W9214A-1	K9709046-011	17.8 J
97504444 GWR2-B854-0	K9709046-014	2.28 J
97504410 GWR2-W856A-0	K9709046-018	0.20 UJ
97504412 GWR2-W856B-0	K9709046-020	0.04 UJ
97504416 GWR2-W857B-0	K9709046-022	0.11 UJ
97504414 GWR2-W857A-0	K9709046-024	0.09 UJ
97504448 GWR2-B878-0	K9709046-028	0.61 J
97504432 GWR2-W9216B-0	K9709046-034	0.10 UJ
97504430 GWR2-W9216A-0	K9709046-037	0.04 UJ
Method Blank	K9709046-MB	0.08 J

Approved By: _____ Date: 1/23/98

gmb 2/3/98

Roy F. Weston, Inc.
Suite 5700
700 5th Avenue
Seattle, Washington 98104-5057
206-521-7600 • Fax 206-521-7601

MEMORANDUM

DATE: 16 February 1998

TO: Sean Sheldrake, WAM, U.S. EPA, Region X

FROM: Jennifer M. Baier, Environmental Chemist, WESTON, Seattle JMB
Roger McGinnis, Senior Environmental Chemist, WESTON, Seattle RMM

SUBJECT: Validation of Total Organic Carbon
SDG: K9709046
Site: Frontier Hard Chrome

WORK ASSIGNMENT NO.:46-38-027N

DOC. CONTROL NO.: 4000-032-001-AABT

WORK ORDER NO.: 4000-032-001-5100-00

cc: Bruce Woods, RAP-WAM, U.S. EPA, Region X
Keith Pine, Project Manager, WESTON, Seattle (memo only)

The quality assurance review of 38 samples, SDG K9709046, collected from Frontier Hard Chrome has been completed. The groundwater samples were analyzed at low level for total organic carbon (TOC) by Columbia Analytical Services of Kelso, WA. The samples were numbered:

97504401	97504403	97504405	97504407	97504409
97504410	97504411	97504412	97504413	97504414
97504415	97504416	97504417	97504419	97504420
97504421	97504422	97504423	97504424	97504425
97504426	97504427	97504428	97504429	97504430
97504431	97504432	97504433	97504435	97504437
97504439	97504441	97504443	97504444	97504445
97504447	97504448	97504449		

Data Qualifications

The following comments refer to the laboratory performance in meeting the quality control criteria described in the technical specifications of the laboratory subcontract.

1. Holding Times

   All samples met holding time criteria.

2. Instrument Detection Limits

   All instrument detection limits (IDL) are equal to or less than the project-required detection limits.

3. Initial and Continuing Calibration

   All results met control limits of 90 to 110 percent recovery of the true value for both initial and continuing calibration.

4. Blanks

   a. Laboratory Method Blanks

      No analytes were detected in laboratory method blanks.

   b. Field Blanks

      No field blank samples were associated with this sample delivery group.

5. Laboratory Control Sample

   The recoveries for TOC were within the control limits.

6. Laboratory Duplicate Sample Analysis

   All relative percent differences (RPD) between analytical results were within the QC limit of 20 percent (or $\pm$ the detection limit for concentrations less than 5 times the detection limit) for water.

7. Spiked Sample Analysis

   Matrix spike recoveries for all analytes met QC criteria of 75 to 125 percent.

8. Field Duplicate Analysis

Samples 97504421 and 97504423 were field duplicates. Results exhibited reasonable agreement.

9. Laboratory Contact

The laboratory was not contacted.

Data Assessment

Upon consideration of the data qualifications noted above, the data are ACCEPTABLE for use except where flagged with data qualifiers that modify the usefulness of the individual values.

Data Qualifiers

U - The material was analyzed for, but was not detected.

UJ - The analyte was not detected. The associated quantitation limit is an estimate because quality control criteria were not met.

J - The analyte was positively identified, but the associated numerical value is an estimated quantity because quality control criteria were not met or because concentrations reported were less than the quantitation limit or lowest calibration standard.

R - Quality control indicates that data are unusable (compound may or may not be present). Resampling and reanalysis are necessary for verification.

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: Roy F. Weston, Inc.
Project: 04000-032-001-5100-00
Sample Matrix: Water

Service Request: K9709046
Date Collected: 12/8-12/10/97
Date Received: 12/8-12/10/97
Date Extracted: NA
Date Analyzed: 12/18/97

Carbon, Total Organic (TOC)
EPA Method 415.1
Units: mg/L (ppm)

Sample Name	Lab Code	MRL	Result
97504429 GWR2-W9215B-0	K9709046-002	0.5	~~ND~~ 0.5 U
97504427 GWR2-W9215A-0	K9709046-004	0.5	~~ND~~ 0.5 U
97504403 GWR2-W853A-0	K9709046-005	0.5	~~ND~~ 0.5 U
97504405 GWR2-W853B-0	K9709046-006	0.5	~~ND~~ 0.5 U
97504425 GWR2-W9214P-0	K9709046-008	0.5	~~ND~~ 0.5 U
97504421 GWR2-W9214A-0	K9709046-010	0.5	16.1
97504423 GWR2-W9214A-1	K9709046-012	0.5	12.8
97504447 GWR2-B856-0	K9709046-013	0.5	4.8
97504445 GWR2-B854-0	K9709046-015	0.5	1.2
504435 GWR2-W9718A-0	K9709046-016	0.5	0.7
97504437 GWR2-W9718B-0	K9709046-017	0.5	~~ND~~ 0.5U
97504411 GWR2-W856A-0	K9709046-019	0.5	~~ND~~ 0.5 U
97504413 GWR2-W856B-0	K9709046-021	0.5	~~ND~~ 0.5 U
97504417 GWR2-W857B-0	K9709046-023	0.5	~~ND~~ 0.5 U
97504415 GWR2-W857A-0	K9709046-025	0.5	~~ND~~ 0.5 U
97504401 GWR2-W851B-0	K9709046-026	0.5	0.6
97504443 GWR2-B862R-0	K9709046-027	0.5	3.0
97504449 GWR2-B878-0	K9709046-029	0.5	1.0
97504439 GWR2-W9719A-0	K9709046-030	0.5	~~ND~~ 0.5 U
97504441 GWR2-W855B-0	K9709046-031	0.5	~~ND~~ 0.5 U
97504409 GWR2-W9719B-0	K9709046-032	0.5	~~ND~~ 0.5 U
97504407 GWR2-W855A-0	K9709046-033	0.5	~~ND~~ 0.5 U
97504433 GWR2-W9216B-0	K9709046-035	0.5	~~ND~~ 0.5 U
97504419 GWR2-W878B-0	K9709046-036	0.5	4.7
97504431 GWR2-W9216A-0	K9709046-038	0.5	1.1
Method Blank	K9709046-MB	0.5	~~ND~~ 0.5 U

Approved By: _____ Date: 1/19/98

gmb 2/3/98

1AMRL/102594

00004

APPENDIX C

STATISTICAL SUMMARY

Frontier Hard Chrome - Comprehensive Data Listing of All 12/97 Groundwater Samples

Constituent	Station ID: / Sample ID: / Sample Date:	B85-4 GWR2-B854-0 12/09/97	B85-6 GWR2-B856-0 12/09/97	B86-2R GWR2-B862R-0 12/09/97	B87-8 GWR2-B878-0 12/10/97	W85-1B GWR2-W851B-0 12/09/97	W85-3A GWR2-W853A-0 12/08/97
Inorganics (Unfiltered) (ug/l)							
Antimony		45.00 U	45.00 U	74.00	45.00 U	48.00	49.00
Arsenic		40.00 U	40.00 U	40.00 U	40.00 U	40.00 U	40.00 U
Beryllium		1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Cadmium		2.00 U	2.00 U	2.00 U	2.00 U	2.00	2.00 U
Chromium		2050.00	351.00	13600.00	706.00	11.00	6.50
Copper		5.70	9.60	4.70	9.80	6.20	4.30
Lead		25.00 U	25.00 U	25.00 U	25.00 U	27.00	25.00 U
Nickel		10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
Selenium		100.00 U	100.00 U	100.00 U	100.00 U	100.00 U	100.00 U
Silver		4.00 U	4.00 U	4.00 U	4.00 U	4.00 U	4.70
Thallium		40.00 U	40.00 U	40.00 U	40.00 U	40.00 U	40.00 U
Zinc		5.20	25.10	8.70	11.00	42.00	4.00 U
Inorganics (Filtered) (ug/l)							
Chromium		2280.00 J			610.00 J		
Hexavalent Chromium		2170.00			554.00		
Iron		49.10	92.10	12.00	1170.00	30.00	10.00 U
Manganese		151.00	1530.00	75.60	877.00	1.00 U	1.00
Conventional Parameters							
Conductivity (us)		365.00	579.00	486.00	257.00	246.00	386.00
Dissolved Oxygen (mg/l)		1.36	0.27	0.12	0.21	1.75	0.63
Redox Potential (mv)		278.60	282.40	287.80	273.40	311.80	178.60
Temperature (degc)		13.88	12.96	13.31	13.95	12.48	14.14
Total Organic Carbon (mg/l)		1.20	4.80	3.00	1.00	0.60	0.50 U
Turbidity (ntu)		151.70	119.80	239.50	114.50	66.50	538.00
pH-FIELD (ph)		6.50	6.52	6.27	6.49	6.78	6.22

A blank cell indicates analysis was not performed or the result was rejected during validation.

Frontier Hard Chrome - Comprehensive Data Listing of All 12/97 Groundwater Samples

Constituent	Station ID: / Sample ID: / Sample Date:	W85-3B GWR2-W853B-0 12/08/97	W85-5A GWR2-W855A-0 12/10/97	W85-5B GWR2-W855B-0 12/10/97	W85-6A GWR2-W856A-0 12/09/97	W85-6B GWR2-W856B-0 12/09/97	W85-7A GWR2-W857A-0 12/09/97
Inorganics (Unfiltered) (ug/l)							
Antimony		45.00 U	45.00 U	53.00	56.00	51.00	50.00
Arsenic		40.00 U	40.00 U	40.00 U	40.00 U	40.00 U	40.00 U
Beryllium		1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Cadmium		2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
Chromium		5.00 U	5.00 U	22.30	212.00	8.90	9.00
Copper		3.30	3.70	3.00 U	3.10	3.90	3.90
Lead		25.00 U	25.00 U	25.00 U	25.00 U	25.00 U	25.00 U
Nickel		10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
Selenium		100.00 U	100.00 U	100.00 U	100.00 U	100.00 U	100.00 U
Silver		4.50	4.00 U	4.00 U	4.00 U	4.00 U	4.00 U
Thallium		48.00	40.00 U	42.00	52.00	49.00	40.00 U
Zinc		4.00 U	4.00 U	4.00 U	4.00 U	4.80	8.90
Inorganics (Filtered) (ug/l)							
Chromium					200.00 UJ	40.00 UJ	90.00 UJ
Hexavalent Chromium					214.00 JH	5.00 UJH	18.00
Iron		10.00 U	10.00 U	10.00 U	12.00	10.00 U	97.90
Manganese		1.00 U	1.00 U	12.40	1.00 U	1.00 U	1.00 U
Conventional Parameters							
Conductivity (us)		265.00	242.00	256.00	267.00	265.00	114.00
Dissolved Oxygen (mg/l)		6.90	0.40	0.64	1.58	2.98	1.62
Redox Potential (mv)		194.20	283.40	286.70	300.70	315.30	306.30
Temperature (degc)		13.00	14.00	13.30	14.58	13.21	13.42
Total Organic Carbon (mg/l)		0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Turbidity (ntu)		147.20	106.20	20.20	9.80	25.80	22.70
pH-FIELD (ph)		6.59	6.45	6.63	6.51	6.75	6.54

A blank cell indicates analysis was not performed or the result was rejected during validation.

Constituent	Station ID: / Sample ID: / Sample Date:	W85-7B GWR2-W857B-0 12/09/97	W87-8B GWR2-W878B-0 12/10/97	W92-14A GWR2-W9214A-CC 12/09/97	W92-14P GWR2-W9214P-0 12/09/97	W92-15A GWR2-W9215A-0 12/08/97	W92-15B GWR2-W9215B-0 12/08/97
Inorganics (Unfiltered) (ug/l)							
Antimony		71.00	45.00 U	45.00 U	58.00	68.00	45.00 U
Arsenic		61.00	40.00 U	40.00 U	40.00 U	40.00 U	40.00 U
Beryllium		1.30 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Cadmium		4.30	2.30	8.90	2.60	2.20	2.00
Chromium		9.80	11.00	22600.00	7620.00	78.20	8.00
Copper		17.00	12.80	117.00	57.80	5.00	3.00 U
Lead		32.00 U	25.00 U	25.00 U	25.00 U	25.00 U	25.00 U
Nickel		13.00 U	10.00 U	20.00	10.00 U	10.00 U	10.00 U
Selenium		130.00 U	100.00 U	100.00 U	100.00 U	100.00 U	100.00 U
Silver		5.20 U	4.00 U	4.00 U	4.00 U	4.00 U	4.00 U
Thallium		67.00	40.00 U	40.00 U	40.00 U	40.00 U	40.00 U
Zinc		80.30	41.10	112.00	14.00	6.40	5.60
Inorganics (Filtered) (ug/l)							
Chromium		110.00 UJ		24600.00 J	7750.00 J	60.00 UJ	120.00 UJ
Hexavalent Chromium		9.00 JH		23200.00	7790.00	43.00	7.00
Iron		34.40	808.00	10.00 U	10.00 U	10.00 U	10.00 U
Manganese		9.35	25.20	6100.00	34.00	8.25	1.00 U
Conventional Parameters							
Conductivity (us)		30.00	94.00	333.00	71.00	242.00	249.00
Dissolved Oxygen (mg/l)		2.78		0.12	0.05	4.50	6.43
Redox Potential (mv)		288.90	255.10	309.00	321.40	226.50	216.00
Temperature (degc)		11.96	12.87	13.70	15.00	13.14	12.80
Total Organic Carbon (mg/l)		0.50 U	4.70	16.10	0.50 U	0.50 U	0.50 U
Turbidity (ntu)		644.00	135.10	30.20	3.80	61.50	209.70
pH-FIELD (ph)		6.85	7.46	6.09	4.99	6.67	6.74

A blank cell indicates analysis was not performed or the result was rejected during validation.

Frontier Hard Chrome - Comprehensive Data Listing of All 12/97 Groundwater Samples

Constituent	Station ID: / Sample ID: / Sample Date:	W92-16A GWR2-W9216A-0 12/10/97	W92-16B GWR2-W9216B-0 12/10/97	W97-18A GWR2-W9718A-0 12/08/97	W97-18B GWR2-W9718B-0 12/08/97	W97-19A GWR2-W9719A-0 12/10/97	W97-19B GWR2-W9719B-0 12/10/97
Inorganics (Unfiltered) (ug/l)							
Antimony		52.00	50.00	52.00	48.00	45.00 U	45.00 U
Arsenic		40.00 U	40.00 U	40.00 U	40.00 U	40.00 U	40.00 U
Beryllium		1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Cadmium		2.30	2.60	2.00 U	2.00 U	2.00 U	2.00 U
Chromium		59.20	12.00	5.00 U	5.00 U	11.00	10.00
Copper		4.70	5.20	5.00	3.30	3.50	6.30
Lead		25.00 U	25.00 U	26.00	25.00 U	25.00 U	27.00
Nickel		10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
Selenium		100.00 U	100.00 U	100.00 U	100.00 U	100.00 U	100.00 U
Silver		4.00 U	4.00 U	4.00 U	4.00 U	4.00 U	4.00 U
Thallium		40.00 U	40.00 U	40.00 U	40.00 U	67.00	40.00 U
Zinc		4.30	27.00	7.20	7.40	6.00	13.00
Inorganics (Filtered) (ug/l)							
Chromium		40.00 UJ	100.00 UJ				
Hexavalent Chromium		67.00	5.00 U				
Iron		25.60	10.00 U	157.00	14.00	80.00	89.50
Manganese		2580.00	9.31	75.20	3.00	1.90	40.40
Conventional Parameters							
Conductivity (us)		292.00	261.00	186.00	297.00	225.00	284.00
Dissolved Oxygen (mg/l)		0.04	0.15	0.05	0.87	0.81	0.34
Redox Potential (mv)		276.40	278.30	246.40	244.00	285.00	287.30
Temperature (degc)		13.42	13.06	14.21	13.11	13.36	12.88
Total Organic Carbon (mg/l)		1.10	0.50 U	0.70	0.50 U	0.50 U	0.50 U
Turbidity (ntu)		360.90	119.40	98.50	214.30	86.40	27.30
pH-FIELD (ph)		6.66	6.78	6.30	6.89	6.56	6.84

A blank cell indicates analysis was not performed or the result was rejected during validation.

Frontier Hard Chrome - Statistical Summary of All 12/97 Groundwater Samples

Constituent	Number of Samples Analyzed	Number of Detections	Detection Frequency (%)	Number of Exceedances	Number of Detected Exceedances	Minimum Detected Value	Maximum Detected Value	Sample Number of Maximum Detected Value	Arithmetic Mean	Median Value	Upper 95% Confidence Limit
Inorganics (Unfiltered) (ug/l)											
Antimony	24	14	58.3	0	0	48	74	GWR2-B862R-0	41.875	48.5	48.1702
Arsenic	24	1	4.2	0	0	61	61	GWR2-W857B-0	21.7083	20	24.6364
Beryllium	24	0	0.0	0	0	n/a	n/a		0.5063	0.5	0.517
Cadmium	24	9	37.5	0	0	2	8.9	GWR2-W9214A-CC	1.8417	1	2.4443
Chromium	24	20	83.3	0	0	6.5	22600	GWR2-W9214A-CC	1975.2458	11	3856.5572
Copper	24	22	91.7	0	0	3.1	117	GWR2-W9214A-CC	12.45	4.85	21.1719
Lead	24	3	12.5	0	0	26	27	GWR2-W851B-0	14.4167	12.5	16.0911
Nickel	24	1	4.2	0	0	20	20	GWR2-W9214A-CC	5.6875	5	6.7594
Selenium	24	0	0.0	0	0	n/a	n/a		50.625	50	51.6963
Silver	24	2	8.3	0	0	4.5	4.7	GWR2-W853A-0	2.2417	2	2.4996
Thallium	24	6	25.0	0	0	42	67	GWR2-W857B-0	28.5417	20	34.0976
Zinc	24	19	79.2	0	0	4.3	112	GWR2-W9214A-CC	18.3333	7.3	27.7558
Inorganics (Filtered) (ug/l)											
Chromium	12	4	33.3	0	0	610	24600	GWR2-W9214A-CC	2968.3333	57.5	6684.3342
Hexavalent Chromium	12	10	83.3	0	0	7	23200	GWR2-W9214A-CC	2839.75	55	6360.3652
Iron	24	14	58.3	0	0	12	1170	GWR2-B878-0	113.4	13	210.6255
Manganese	24	17	70.8	0	0	1	6100	GWR2-W9214A-CC	480.7129	9.33	950.4987
Conventional Parameters											
Conductivity (us)	24	24	100.0	0	0	30	579	GWR2-B856-0	262.1667	259	304.278
Dissolved Oxygen (mg/l)	23	23	100.0	0	0	0.04	6.9	GWR2-W853B-0	1.5043	0.64	2.2141
Redox Potential (mv)	24	24	100.0	0	0	178.6	321.4	GWR2-W9214P-0	272.2292	282.9	285.3752
Temperature (degc)	24	24	100.0	0	0	11.96	15	GWR2-W9214P-0	13.4058	13.305	13.6439
Total Organic Carbon (mg/l)	24	9	37.5	0	0	0.6	16.1	GWR2-W9214A-CC	1.5396	0.25	2.7202
Turbidity (ntu)	24	24	100.0	0	0	3.8	644	GWR2-W857B-0	148.0417	110.35	204.5672
pH-FIELD (ph)	24	24	100.0	0	0	4.99	7.46	GWR2-W878B-0	6.545	6.575	6.6953

n/a - Criteria not available